C_{pt} = net pressure coefficients as given in Table 2.12.2.2

S_R = rafter spacing, i.e. 0.6 or 1.2 m

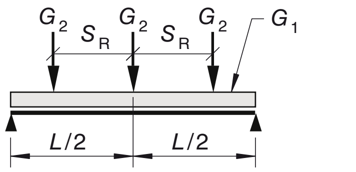
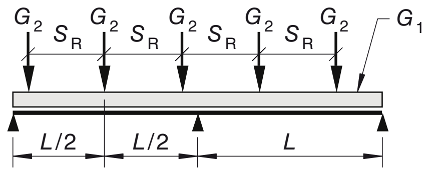
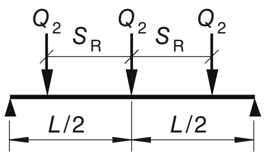
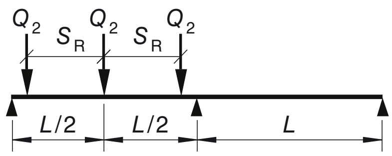
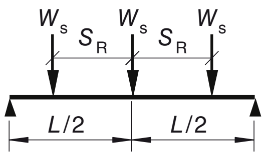
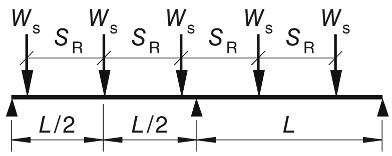
RLW = roof load width for the verandah beam, in metres

2.12.3.2 *Structural models and action categories for serviceability design*

The structural models for which deflections are calculated shall be as given in Table 2.12.3.2. Action cases given in Table 2.12.3.2 are divided into action categories for the purpose of allowing for duration of load on stiffness as specified in Clause 2.12.3.3.

TABLE 2.12.3.2

STRUCTURAL MODELS AND ACTION CATEGORIES—SERVICEABILITY

Action category	Structural models	
	Single span	Continuous span
1		
2		
3		

LEGEND:
S_R = rafter spacing, 0.6 m or 1.2 m

2.12.3.3 *Calculation of deflection*

The requirements of AS 1720.1 for the calculation of deflection shall be applied using the duration of load factor for creep deformation as given in Table 2.12.3.3.

TABLE 2.12.3.3

LOAD DURATION FACTORS FOR DEFORMATION

Initial moisture content	Load duration factor (j_2)	
	Action category 1	Action categories 2 and 3
Seasoned	2.0	1.0
Unseasoned	3.0	1.0

2.12.3.4 *Serviceability limits*

The limits on deflection used to define the serviceability limit states are given in Table 2.12.3.4.

TABLE 2.12.3.4

LIMITS ON DEFLECTION

Action category	Deflection limits
1	Span/400 or 10 mm max.
2	Span/250 or 12 mm max.
3	Span/200

SECTION 3 DESIGN OF WALL MEMBERS

3.1 POSTS

3.1.1 Description

Posts are loadbearing columns designed to support axial loads arising from the vertical support given to roofs and floors.

Posts may be incorporated within or installed separate from walls. Posts are not used to replace common studs in external walls and are, therefore, not designed to support lateral loads.

Posts are assumed laterally supported only at points of attachment to floor and roof members (see Figure 3.1.1).

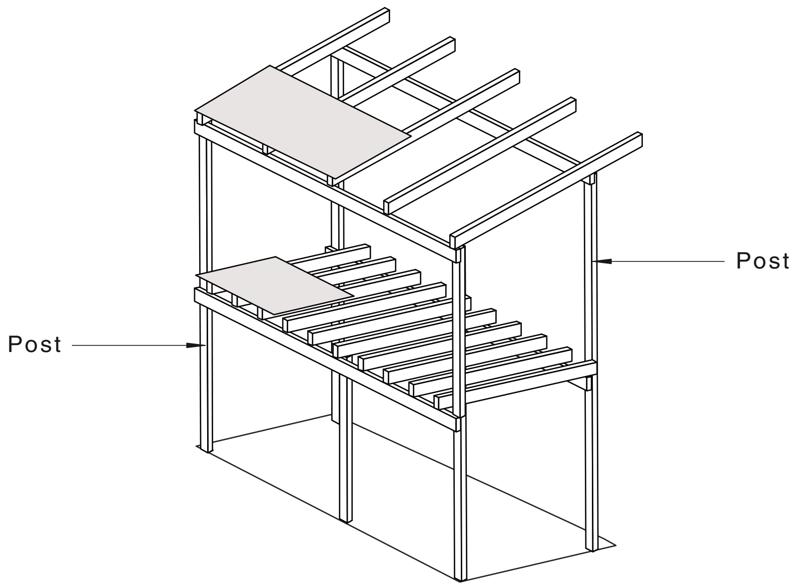


FIGURE 3.1.1 POSTS SUPPORTING ROOF AND/OR FLOOR LOADS

3.1.2 Design for safety

3.1.2.1 *General consideration*

Design for safety requires consideration of the strength limit states in tension and compression.

3.1.2.2 *Design actions*

The actions used for the determination of the design action effects shall be as follows:

(a) *Permanent* Permanent action, G, is considered as the sum of the concentrated permanent actions from supported roof and floor areas determined from Table 3.1.2.2(A).

TABLE 3.1.2.2(A)

PERMANENT ACTIONS

Source of action	Permanent action, (G) kN
Floor	$0.4A_F$
Roof:	
Tile	$0.9A_R$
Sheet	$0.4A_R$

LEGEND:
A_F = area of floor supported, in square metres
A_R = area of roof supported, in square metres

(b) *Imposed* Concentrated imposed actions, Q_1, Q_2 and Q_3 (in kN), arising from support given to floor and roof areas are determined from:

(i) *For posts supporting floor area* (A_F):

(A) *Permanent live load*—$Q_1 = 0.5A_F$.

(B) *Transient live load*—$Q_2 = 1.5A_F$.

(ii) *For posts supporting roof area* (A_R)—$Q_3 = 0.25A_R$.

NOTES:

1 Imposed actions Q_2 and Q_3 are not considered to act simultaneously.

2 Units for areas A_F and A_R are square metres.

(c) *Wind* The concentrated wind action, W_u (in kN), applicable for the strength limit state arising from support given to roof areas is determined from—

$$W_u = q_u C_{pt} A_R \qquad \ldots 3.1.2.2$$

where

q_u = free stream dynamic gust pressure, in kPa, for the ultimate limit state; values of q_u are given in Appendix A, Table A2, for each wind classification

C_{pt} = net pressure coefficients for roof areas supported by posts, as given in Table 3.1.2.2(B)

A_R = roof area supported, in square metres

TABLE 3.1.2.2(B)

NET PRESSURE COEFFICIENTS FOR ROOF AREAS SUPPORTED BY POSTS—STRENGTH

Wind classification	C_{pt}
N1 to N4	+0.95 or −1.44
C1 to C3	

3.1.2.3 *Structural models and action categories for strength design*

Posts are designed as simple columns supporting an axial concentrically applied load. Action combinations used to determine the design action effects in compression (N_c^*) and tension (N_t^*) shall be as given in Table 3.1.2.3. Design action effects given in Table 3.1.2.3 are divided into action categories that are used for the determination of the corresponding member design capacity as specified in Clause 2.8.2.4.

TABLE 3.1.2.3

DESIGN ACTION EFFECTS AND ACTION CATEGORIES—STRENGTH

Action categories	Design action effects
1	$N_c^* = 1.35G$ $N_c^* = 1.2G + 1.5Q_1$
2	$N_c^* = 1.2G + 1.5Q_2$
3	$N_c^* = 1.2G + 1.5Q_3$
4	$N_c^* = 1.2G + W_u\downarrow + Q_1$ $N_t^* = 0.9G + W_u\uparrow$

3.1.2.4 *Member design capacity*

The requirements of AS 1720.1 shall be applied to determine member design capacities in compression and tension. The following assumptions and modification factors shall be used:

(a) *Load duration factor* The member design capacity includes the modification factor for load duration (k_1). Values of k_1 appropriate for each action category, as defined in Table 3.1.2.3, shall be as given in Table 3.1.2.4.

(b) *Moisture content of timber*:

(i) *Unseasoned timber*—for action categories 2, 3 and 4, use values of k_4 appropriate for thickness as given in AS 1720.1. For Action category 1, $k_4 = 1.0$.

(ii) *Seasoned timber*—$k_4 = 1.0$ for all action categories.

(c) *Strength sharing* Strength sharing is not considered to apply for posts, i.e. $k_9 = 1.0$.

(d) *Member restraint* For the determination of the compressive capacity of posts the effective length for buckling about either axis is taken as 0.85 times the post height. Post height is the distance between supports and points of attachment to supported floor and roof members, which are assumed to provide lateral restraint for both axes of buckling.

NOTE: Nail-laminated posts are not considered in this Standard.

TABLE 3.1.2.4

LOAD DURATION FACTORS FOR STRENGTH

Action category	Load duration factor (k_1)
1	0.57
2	0.8
3	0.94
4	1.00

3.1.3 Design for serviceability

Axial deformation of posts under the applicable loadings is small and for this reason serviceability design for posts shall be disregarded.

3.2 LOADBEARING WALL STUDS

3.2.1 Description

Loadbearing wall studs are the vertical components of a loadbearing wall required to transfer tension or compression loads from supported floors or roofs and to transfer horizontal wall loads, in bending, to the top and bottom wall supports.

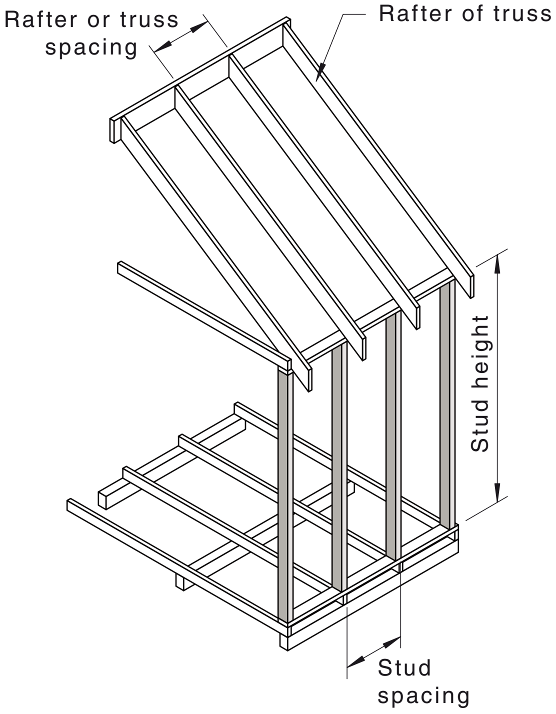
Common studs support the vertical loads applied to the top wall plate by rafters, ceiling joists or floor joists and the horizontal loads due to wind.

Jamb studs are studs at sides of openings that support loads from the lintel over the opening and horizontal wind loads related to the width of the opening.

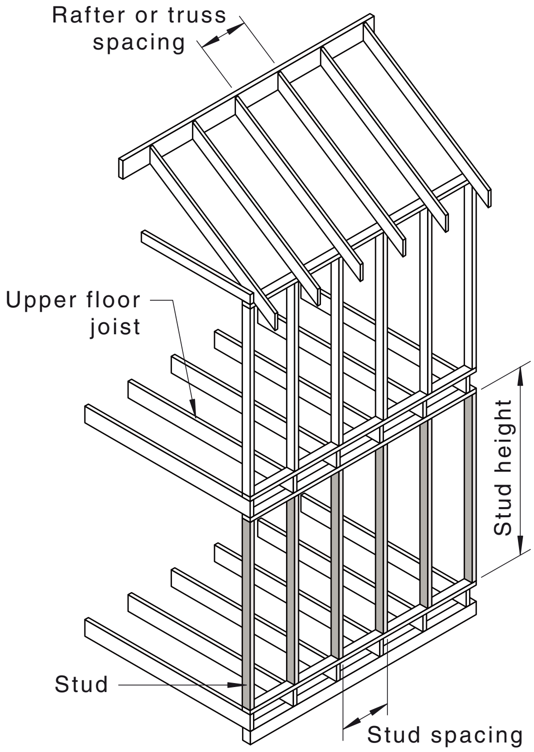
Studs supporting concentrated loads are studs installed in the wall, in addition to common studs (or jamb studs), that are required to carry concentrations of vertical load arising from support for principal roof or floor supporting members.

Special consideration is given for studs notched for the installation of bracing. For notched studs, notches are assumed in either face of the wall penetrating to a maximum depth of 20 mm into the depth of the studs (see Figure 3.2.1).

NOTE: For maximum allowable stud heights refer AS 1684 series.



(a) Single or upper storey



(b) Lower storey

FIGURE 3.2.1 LOADBEARING WALL STUDS

3.2.2 Design for safety

3.2.2.1 *General consideration*

Design for safety requires consideration of the strength limit states in compression, tension, bending, combined bending and compression and combined bending and tension. For notched studs the strength limit state for combined bending and shear at the assumed notch location shall also be considered.

3.2.2.2 *Design actions*

The actions used for the determination of the design action effects shall be as follows:

(a) *Permanent* The concentrated permanent actions (G) considered axially applied to common studs, jamb studs and studs supporting concentrated loads, in upper or single storey walls or lower storey of two-storey walls, are determined from Table 3.2.2.2(A).

TABLE 3.2.2.2(A)

AXIAL PERMANENT ACTIONS SUPPORTED BY STUDS

Application	**Common studs**	**Jamb studs**	**Studs supporting concentrated loads**
	Axial dead loads, (G) kN		
Upper storey or single storey—			
(a) sheet roof	$0.4(RLW)S_1$	$0.4(RLW)(W_o/2 + 0.3)$	$0.4A_R$
(b) tile roof	$0.9(RLW)S_1$	$0.9(RLW)(W_o/2 + 0.3)$	$0.9A_R$
Lower storey of two-storey:			
(a) Roof, upper wall and floor—			
(i) sheet roof	$[0.4(RLW) + 0.4 + 0.4(FLW) + 0.025(FLW)^2]S_2$	$[0.4(RLW) + 0.4 + 0.4(FLW) + 0.025(FLW)^2](W_o/2 + 0.3)$	—
(ii) tile roof	$[0.9(RLW) + 0.4 + 0.4(FLW) + 0.025(FLW)^2]S_2$	$[0.9(RLW) + 0.4 + 0.4\ (FLW) + 0.025(FLW)^2](W_o/2 + 0.3)$	—
(b) Floor only	$[0.4(FLW) + 0.025(FLW)^2]S^2$	$[0.4(FLW) + 0.025(FLW)^2]\ (W_o/2 + 0.3)$	$0.4A_F$

LEGEND:

S_1 = the greater of the rafter (truss) or stud spacing in the wall, in metres

S_2 = the greater of the floor joist or stud spacing in the lower wall, in metres

W_o = width of opening in the wall, in metres

A_R = area of roof supported by the stud, in square metres

A_F = area of floor supported by the stud, in square metres

RLW = roof load width supported by the wall, in metres

FLW = floor load width supported by the wall, in metres

(b) *Imposed* Concentrated imposed actions, Q_1, Q_2 and Q_3 (in kN), considered axially applied to common studs, jamb studs and studs supporting concentrated loads, in upper or single storey walls or the lower storey of two-storey construction, are determined from Table 3.2.2.2(B).

TABLE 3.2.2.2(B)
AXIAL IMPOSED ACTIONS SUPPORTED BY STUDS

Application	Common studs	Jamb studs	Studs supporting concentrated loads
	Axial imposed actions, (Q) kN		
Upper storey or single storey	$Q_1 = 0$	$Q_1 = 0$	$Q_1 = 0$
	$Q_2 = 0.25(RLW)S_1$	$Q_2 = 0.25(RLW)(W_o/2 + 0.3)$	$Q_2 = 0.25A_R$
	$Q_3 = 0$	$Q_3 = 0$	$Q_3 = 0$
Lower storey of two-storey	$Q_1 = 0.5(FLW)S_2$	$Q_1 = 0.5(FLW)(W_o/2 + 0.3)$	$Q_1 = 0.5A_F$
	$Q_2 = 0$	$Q_2 = 0$	$Q_2 = 0$
	$Q_3 = 1.5(FLW)S_2$	$Q_3 = 1.5(FLW)(W_o/2 + 0.3)$	$Q_3 = 1.5A_F$

LEGEND:

RLW = roof load width supported by the wall, in metres
FLW = floor load width supported by the wall, in metres
S_1 = greater of the rafter/truss or stud spacing, in metres
S_2 = greater of the floor joist or stud spacing, in metres
W_o = width of opening in the wall, in metres
A_R = area of roof supported by the stud, in square metres
A_F = area of floor supported by the stud, in square metres
Q_1 = long-term component of floor live load
Q_2 = roof imposed action
Q_3 = short term floor imposed action

(c) *Wind* Wind actions for studs are considered applied as axial concentrated actions (W_{ua}) and uniformly distributed lateral actions (W_{uw}). Values of W_{ua} and W_{uw}, for common studs, jamb studs and studs supporting concentrated loads, are determined from the expressions given in Table 3.2.2.2(C).

TABLE 3.2.2.2(C)
AXIAL AND LATERAL WIND ACTIONS FOR STUDS

Type of load		Common studs	Jamb studs	Studs supporting concentrated loads
Upper storey or single storey	W_{ua} (kN)	$q_u C_{ptr}(RLW)S_1$	$q_u C_{ptr}(RLW)(W_o/2 + 0.3)$	$q_u C_{ptr} A_R$
	W_{uw} (kN/m)	$q_u C_{ptw} S_s$	$q_u C_{ptw}(W_o/3 + 0.3)$	Not applicable
Lower storey of two-storey	W_{ua} (kN)	$q_u C_{ptr}(RLW)S_s$	$q_u C_{ptr}(RLW)(W_o/2 + 0.3)$	Not considered
	W_{uw} (kN/m)	$q_u C_{ptw} S_s$	$q_u C_{ptw}(W_o/3 + 0.3)$	Not applicable

LEGEND:

q_u = free stream dynamic gust pressure for the ultimate limit state; values of q_u are given in Appendix A, Table A2, for each wind classification
C_{ptr} = net pressure coefficients for roof areas supported by the wall as given in Table 3.2.2.2(D)
C_{ptw} = net pressure coefficients for walls, as given in Table 3.2.2.2(D)
S_1 = for wind down—the rafter spacing, in metres
= for wind up—tie-down spacing, in metres
S_s = stud spacing, in metres
W_o = width of opening between jamb studs, in metres
A_R = roof area supported, in square metres

TABLE 3.2.2.2(D)

PRESSURE COEFFICIENTS FOR ROOF AND WALLS—STRENGTH

Wind classification	C_{ptr}	C_{ptw}
N1 to N4	+0.63 or −0.99	0.9
C1 to C3	+0.95 or −1.44	1.20

NOTE: Positive pressure coefficient indicates an inwards pressure.

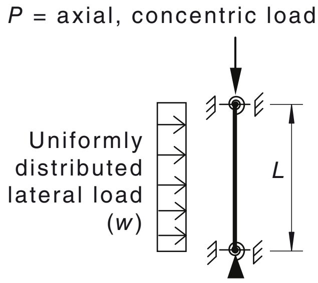
3.2.2.3 *Structural models and action categories for strength design*

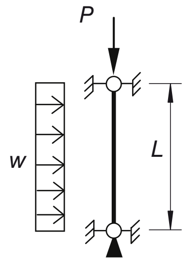
The structural model used to calculate the member design action effects shall be as shown in Table 3.2.5. For the determination of design action effects, axial actions are assumed concentrically applied and maximum bending moments are as given in Table 3.2.2.3.

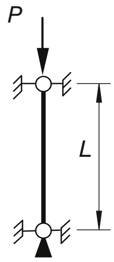
Action combinations given in Table 3.2.2.3 are divided into action categories that are used for the determination of the corresponding member design capacity as specified in Clause 3.2.2.4.

TABLE 3.2.2.3

STRUCTURAL MODEL AND ACTION CATEGORIES—STRENGTH

<table>
<tr><th colspan="3">Structural model</th></tr>
<tr><th>Common stud</th><th>Jamb stud</th><th>Studs supporting concentrated loads</th></tr>
<tr><td>

NOTES:
1 For notched studs, the notch is assumed located at mid-height.
2 $M = cwL^2$
where
(a) for $L \leq 2.4$ m, $c = 0.07$;
(b) for $L \geq 4.2$ m, $c = 0.125$; and
(c) for $2.4 < L < 4.2$, $c = (0.0306L - 0.003)$.</td>
<td>

$M = 0.125wL^2$</td>
<td>

$M = 0$</td></tr>
<tr><th>Action category</th><th colspan="2">Design actions</th></tr>
<tr><td>1</td><td colspan="2">$P = 1.35G$ and $w = 0$
$P = 1.2G + 1.5Q_1$ and $w = 0$</td></tr>
<tr><td>2</td><td colspan="2">$P = 1.2G + 1.5Q_3$ and $w = 0$</td></tr>
<tr><td>3</td><td colspan="2">$P = 1.2G + 1.5Q_2$ and $w = 0$</td></tr>
<tr><td>4</td><td colspan="2">$P = 1.2G + W_{ua}\downarrow + Q_1$ and $w = W_{uw}$
$P = 0.9G + W_{ua}\uparrow$ and $w = W_{uw}$
$P = 1.2G + Q_1$ and $w = W_{uw}$</td></tr>
</table>

3.2.2.4 *Member design capacity*

The requirements of AS 1720.1 shall be applied to determine member design capacities in compression, tension and bending and in combined bending and compression and bending and tension. The following assumptions and modifications factors shall be used:

(a) *Load duration factor* The member design capacity includes the modification factor for load duration (k_1). Values of k_1 appropriate for each action category, as defined in Table 3.2.2.3, are given in Table 3.2.2.4.

(b) *Moisture content of timber*:

(i) *Unseasoned timber*—for Action category 4 in Table 3.2.2.3, use values of k_4 appropriate for thickness as specified in AS 1720.1. For Action categories 1, 2 and 3, $k_4 = 1.0$.

(ii) *Seasoned timber*—$k_4 = 1.0$ for all action categories.

(c) *Strength sharing*:

(i) *For common studs*—the strength sharing factor (k_9) is applied for bending only, assuming $n_{mem} = 5$ and n_{com} = number of sections combined in a stud.

(ii) *For jamb studs*—the strength sharing factor (k_9) is applied for bending only, with $n_{mem} = 1.0$ and n_{com} = number of sections combined in the jamb stud.

(iii) *For studs supporting concentrated loads*—the strength sharing factor (k_9) is not applied.

(d) *Member restraint* For the determination of bending and compressive capacity, the following assumptions relating to lateral restraint are used:

(i) *For bending*:

(A) *At supports*—studs are assumed torsionally restrained.

(B) *Between supports*—studs are assumed torsionally and laterally restrained by noggings; $L_{ay} = 1350$ mm. In addition, the tension edge is assumed laterally restrained at intervals not greater than 600 mm.

(ii) *For compression*:

(A) For buckling about the major axis the effective length of studs is taken as $g_{13}L$, where L is the height of the stud and g_{13} is determined as follows:

(1) *For common studs*:

$L \leq 2.4$ m, $g_{13} = 0.75$.

$L \geq 4.2$ m, $g_{13} = 1.0$.

2.4 m $\leq L \leq$ 4.2 m, $g_{13} = (0.139L + 0.417)$.

(2) *For jamb studs*—$g_{13} = 0.9$.

(B) For buckling about the minor axis, L_{ay} is taken as 600 mm.

NOTE: For studs formed by nail laminating one or more sections together, the breadth of section used to determine the slenderness coefficients (S_1 or S_4) is taken as the breadth of an individual lamination.

(e) *Notched studs* For studs up to 125 mm deep, notched to a maximum depth of 20 mm for the installation of diagonal bracing only, the bending capacity is determined as 0.6 times the bending capacity of an un-notched stud. The tensile and compressive capacities are determined using the net cross-section at the notch as the effective cross-sectional area.

NOTE: The method used for studs notched for diagonal bracing is based upon CSIRO BCE Report, *Notched composite beams*, Dec. 97/169M, September 1997.