BRANZ

build

Supplement

The RIGHT STUFF

Bracing

WWW.BRANZ.CO.NZ

YOU'RE PROTECTED WITH GIB EZYBRACE® SYSTEMS.

For over 30 years, Kiwi building professionals like you have been relying on GIB® bracing systems. Designed and tested in New Zealand for local conditions, they meet and exceed New Zealand's stringent building codes and are backed by local technical support. So you can build with confidence and complete peace of mind.*

GIB EzyBrace® Systems software and technical literature is available at gib.co.nz/ezybrace. Or for technical support call the GIB® Helpline on 0800 100 442.

DOWNLOAD THE
GIB® APP NOW
Go to your App Store
or Google Play Store.

J1/WWB0020/BLD

GIB® is a registered trademark. *Provided they are used, stored, installed and maintained strictly in accordance with current Winstone Wallboards technical information.

build

BRANZ

Supplement

The RIGHT STUFF

Bracing

ISSN: 0110 4381

www.branz.co.nz

GIB® PLASTERBOARD SYSTEMS

BEST PRACTICE SERIES

No.2 BRACING REQUIREMENTS

GIB EzyBrace® Systems comply with the requirements of NZS 3604:2011. When designed and installed in accordance with GIB EzyBrace® Systems 2011 and the GIB® Site Guide 2010, they provide resistance to wind and earthquake forces.

For your FREE copy, call the GIB® Helpline on **0800 100 442** or view it online at **gib.co.nz/ezybrace.** The website has further bracing information including the 'Efficient Bracing Design' Bulletin.

To book free on-site training, go to **gib.co.nz/skills-maintenance-request-form** or call the GIB® Helpline.

LOOK BEYOND THE SURFACE®

7 THINGS TO CONSIDER WHEN INSTALLING GIB EZYBRACE® SYSTEMS.

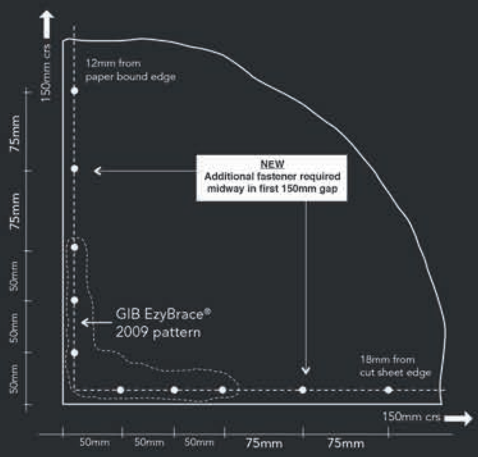
These recommendations are not a substitute for the full information contained in relevant GIB® technical literature. Please familiarise yourself with the literature before proceeding with any project.

DESIGN

1. Check that full length wall panels have been designated as bracing elements. Using part walls is inefficient and can cause finishing issues due to different lining requirements and unnecessary fastener lines.
2. Check that GS1-N and GS2-N bracing elements have been used where available and that high performance bracing elements have been specified efficiently and only where needed (e.g. building corners, narrow panels supporting lintels over window or openings).
3. Discuss the bracing layout with your designer or call the GIB® Helpline for assistance.

INSTALLATION

4. Fasten the perimeter of GIB® plasterboard in bracing elements with nominated fasteners at 150 mm centres using the bracing corner fastener pattern as illustrated.



5. The nomination of GIB® bracing elements is simple.

   The most common elements are:

   GS1-N: inside of external walls (GIB® Standard one side and no special hold-down brackets)

   GS2-N: commonly for internal walls (GIB® Standard both sides and no specific hold-down brackets)

   High performance elements include:

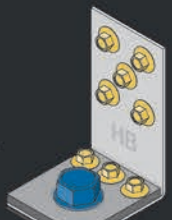
   GSP-H: GIB® Standard one side and plywood the other

   BL1-H: GIB Braceline® one side

   BLP-H: GIB Braceline® one side and plywood the other

   BLG-H: GIB Braceline® one side and GIB® Standard the other

6. The 'H' indicates that all these have special hold-down brackets at the ends of the element. Winstone Wallboards recommends using the GIB Handibrac®. The BOWMAC screw bolt has a minimum characteristic uplift strength of 15Kn.



7. GIB® Grabber® screws (with the 'G' on the head) have been tested for use in GIB® Bracing systems.

BRANZ Appraised
Appraisal No.294 [2011]

GIB®

J1/WWB0431/BLD

GIB® is a registered trademark.

1 Introduction

PROVIDING SUFFICIENT BRACING CAPACITY FOR WIND AND EARTHQUAKE IS AN INTEGRAL PART OF THE DESIGN PROCESS.

BRACING OF A TIMBER-FRAMED BUILDING is required to resist horizontal wind and earthquake loads. The bracing demand to resist wind is expressed in bracing units (BUs) per lineal metre and bracing units per square metre for earthquakes.

This compilation of articles from *Build* magazine looks at the bracing requirements for buildings built in accordance with NZS 3604:2011 *Timber-framed buildings*.

It starts by looking at what information is needed to start calculating bracing and to determine what needs to be provided for bracing calculations. It then works its way through the bracing requirements for various parts of the building, from subfloor to wall to roof, using examples to illustrate how to apply NZS 3604:2011. ◀

Any standard referred to within this publication can be purchased from Standards New Zealand by phoning 0800 782 632 or by visiting www.standards.co.nz.

Please note, the BRANZ books and bulletins mentioned in this publication may be withdrawn at any time. For more information and an up-to-date list, visit BRANZ Shop online at www.branz.co.nz or phone BRANZ 0800 80 80 85, press 2.

2 Bracing using NZS 3604:2011

IN PREPARATION FOR WORKING OUT BRACING REQUIREMENTS FOR A BUILDING, SOME INFORMATION NEEDS TO BE COLLECTED.

BEFORE STARTING BRACING CALCUALTIONS, the designer will need to collect the following information for the specific building.

NZS 3604:2011

Is the building being considered within the scope of NZS 3604:2011? For this, it must be no more than 2-storeys and a maximum height of 10 m from the lowest ground level to the uppermost portion of the roof.

Designs within the scope of NZS 3604:2011 must provide bracing capacity that exceeds the *higher* of the minimum requirements in NZS 3604:2011 for:

- wind demand – Tables 5.5, 5.6 and 5.7
- earthquake demand – Tables 5.8, 5.9 and 5.10.

Wind zone

Some territorial authorities have maps with wind zones. Otherwise, see NZS 3604:2011 5.2.1 to work out the wind zone. Steps to do this are also on pages 8–10, or consult an engineer.

When the structure is situated in a lee zone, also see the increased requirements in the notes at the bottom of Table 5.4.

Earthquake zone

Establish the earthquake zone from NZS 3604:2011 Figure 5.4. For Christchurch, refer to Building Code clause B1 3.1.2.

Floor plan area

What is the floor plan area in square metres at the level being considered? This is needed for earthquake demand calculations – the total floor

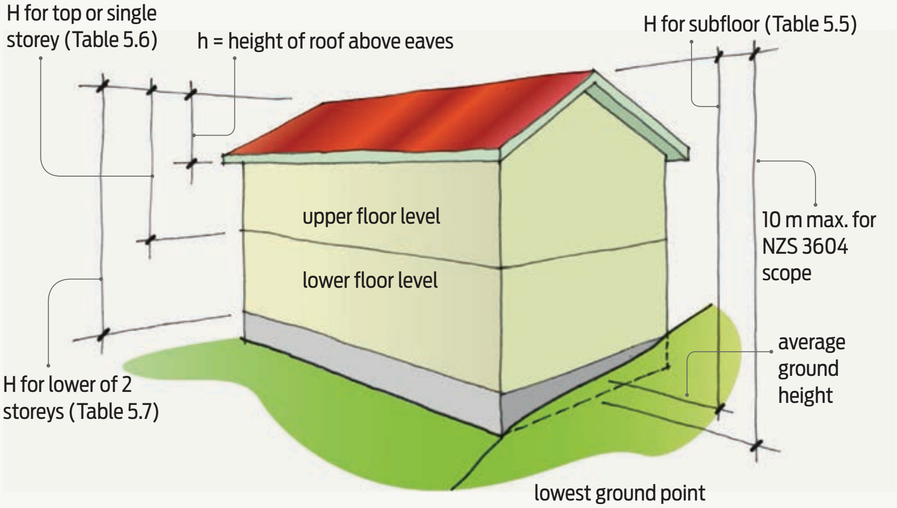


Figure 1 How to work out H and h.

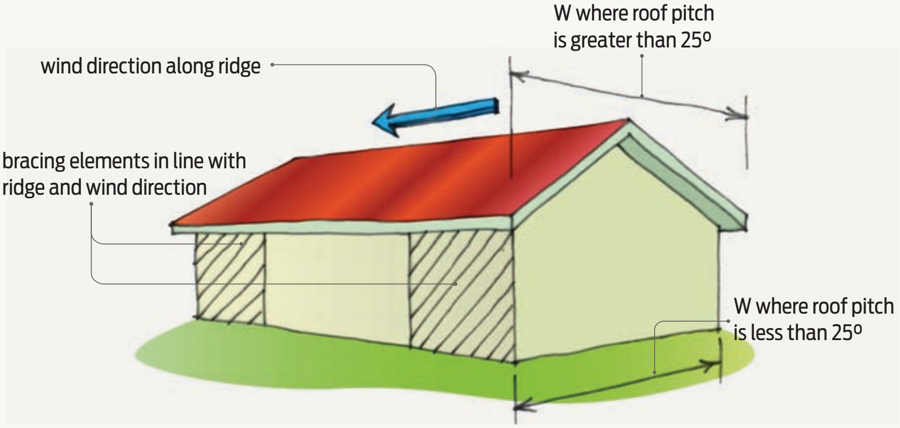


Figure 2 Bracing for wind along the ridge.

area of the level being considered is multiplied by the values given in Tables 5.8, 5.9 and 5.10.

Weight of claddings

Wall claddings are separated into:

- light wall cladding – has a mass up to 30 kg/m^2, for example, weatherboards
- medium wall cladding – has a mass over 30 kg/m^2 and up to 80 kg/m^2, for example, stucco
- heavy wall cladding – has a mass over 80 kg/m^2 and up to 220 kg/m^2, for example, clay and concrete veneers (bricks).

Roofs are either:

- light roof – has roofing material (and sarking where required) with a mass up to 20 kg/m^2 of roof area, for example, profiled metal roofing
- heavy roof – has roofing material (and sarking where required) with a mass over 20 kg/m^2 and up to 60 kg/m^2 of roof area, for example, concrete or clay tiles, slates.

Site subsoil class for earthquake calculations

Site subsoils are classified in NZS 3604:2011 C5.3.3 as:

- class A – strong rock
- class B – rock
- class C – shallow soil sites
- class D – deep or soft sites
- class E – very soft soil sites.

Territorial authorities often have maps with the soil classifications. If this information is not available, site subsoil classification class E must be used or specific engineering design carried out.

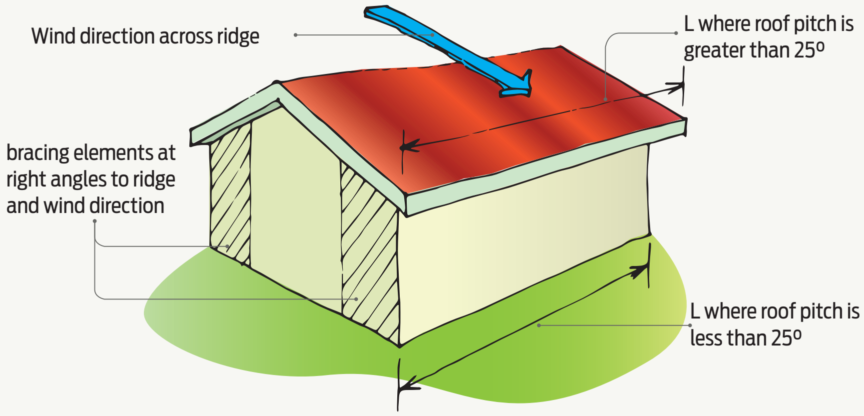


Figure 3 **Bracing for wind across the ridge.**

The type of soil class is needed to calculate the bracing units required to resist earthquakes. For multiplication factors for soil types see:

- Table 5.8 – single storey on subfloor framing for various wall and roof claddings
- Table 5.9 – 2-storey on subfloor framing for various wall and roof claddings
- Table 5.10 – single and 2-storey on slab for various wall and roof claddings.

Building shape

What is the building shape? NZS 3604:2011 clause 5.1.5 sets out the requirements for buildings that have:

- wings or blocks that extend more than 6 m from the building – these need sufficient bracing individually
- split-level floors – each level to have sufficient bracing individually and to have wall and subfloor bracing at the position of the discontinuity
- floors or ceilings with a step more than 100 mm in the finished levels – a *bracing line* is required in the storey below at the location of the discontinuity, and the *bracing element* in the storey below must run continuously from the storey below to the underside of the upper levels. ➤

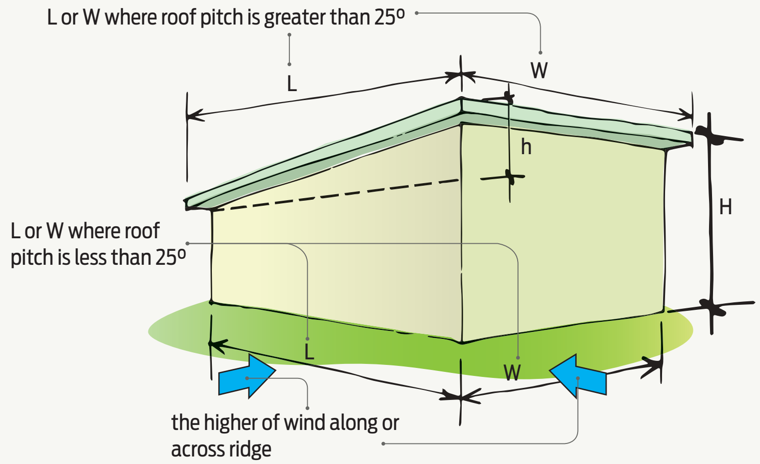


Figure 4 Dimensions for mono-pitched roofs.

Heights of buildings

Use NZS 3604:2011 Figure 5.3 to establish heights H and h for bracing applications. H may have different values for different sections of the same building (see Figure 1), for example:

- for subfloor bracing requirements, H = the average height of finished ground level to the roof apex (use Table 5.5)
- for a single or upper floor level, H = single or upper finished floor level to roof apex (use Table 5.6)
- for lower finished floor level, H = lower finished floor level to roof apex (use Table 5.7)
- for roof height above the eaves, h = apex of roof to bottom of eaves (use Table 5.5, 5.6 and 5.7).

Roof types

What is the type(s) of roof? NZS 3604:2011 Figure 5.3 shows where bracing needs to be in relation in wind direction.

Gable roof – wind along ridge

Bracing elements to resist wind are placed in line with the ridge and wind direction (see Figure 2).

To calculate the required bracing units along the building, multiply W by the value in the right-hand 'Along' column in NZS 3604:2011 Table 5.5 (subfloor), 5.6 (upper or single-level walls) or 5.7 (lower of 2 storeys). These tables are for high wind zone. In other zones, use the multiplying factor for the relevant wind zone found at the bottom of the relevant table.

Gable roof – wind across ridge

Bracing elements for wind across the building are positioned in line with the wind direction and at right angles to the ridge line (see Figure 3).

To calculate the bracing units required in the across direction, multiply L by the value in the 'Across' column in NZS 3604:2011 Table 5.5 (subfloor), 5.6 (upper or single level walls) or 5.7 (lower of 2 storeys). As above, if not in a high wind zone use the relevant wind zone multiplying factor at the bottom of the table.

Hip roofs

Use 'Across' values in NZS 3604:2011 Tables 5.5, 5.6 and 5.7 for along and across directions.

Mono-pitched roofs

Roof height above the eaves is taken as the difference between lower eaves height and roof apex (see Figure 4).

When roof pitch is:

- 25º or less, use wall width or length
- greater than 25º, use roof dimensions.

To calculate the bracing units required, use the higher value of the along and across calculations in NZS 3604:2011 Tables 5.5, 5.6 and 5.7 is used.

Limitations on bracing allocation

Based on hold-down capabilities, there are some maximum ratings for bracing elements that can be used in calculations. The maximum for:

- timber floors is 120 bracing units/metre
- concrete floors is 150 bracing units/metre.

The bracing design should evenly distribute the bracing throughout the building rather than concentrating them in ends of buildings or outside walls.

Extra B/Us for part storey and chimneys

Where there is a part storey contained in a:

- timber-framed basement, regard the building as two buildings for demand calculations – one 2-storey (has basement underneath) and one single-storey – and use the appropriate tables
- roof space, the bracing demand values in Tables 5.8, 5.9 and 5.10 (earthquake) must be increased by 4 bracing units/square metre.

Where a masonry or concrete chimney is dependent on the building structure for lateral support, additional demand is also required – see B1/AS3. ◄

Note Several suppliers of wall bracing systems provide free on-line calculators to work out bracing requirements.


ACCEL™
BRACE YOURSELF.


ACCEL™
James Hardie
a smarter way™
Home
Contact Us
About ACCEL™
About James Hardie
Terms & Conditions
Legal
Privacy
more>
Talk to an Expert
Product Information
Product Calculator
Multimedia
Technical Literature
CAD Details
Training
Sustainability
Solution Centre

3

Wind zones and NZS 3604

OFTEN WIND DETERMINES THE BRACING REQUIREMENT FOR TIMBER-FRAMED BUILDINGS. WE WALK THROUGH HOW TO FIND THE CORRECT WIND ZONE FOR A SITE USING NZS 3604:2011.

FOUNDATIONS AND WALLS of timber-framed buildings must be braced to resist the horizontal forces from earthquakes and wind. When designing bracing, calculations of both earthquake and wind forces (called bracing demand) must be made and the building constructed to withstand the stronger of the calculated forces (called bracing capacity). Although New Zealand lies in a region of high seismic activity, it is often the horizontal forces imposed by wind that determine the bracing requirement.

The shape, size and level (whether basement, ground or first floor) of the building, as well as its actual location, all affect the wind bracing demand, but in order to calculate the bracing demand, the wind zone, rated as low (L) to extra high (EH) wind speed, must first be determined.

Six steps to determine wind zone

A means of determining the wind zone for a specific location is in NZS 3604:2011 Table 5.1 (see Table 1). This describes a six-step process.

Step 1 – Wind region

The first step is to identify the wind region for the building from NZS 3604:2011 Figure 5.1. This map divides the country into two wind regions – A and W – based on wind speed data from the New Zealand MetService.

The regions are too general, however, as land formations can modify and create significant localised variations to wind speeds. For example, wind speed will increase as it passes over and between hills and decrease when passing over rough ground.

Figure 5 Built-up residential areas are generally defined as urban.

Figure 6 Sites adjacent to an open space such as a playing field are defined as exposed. The buildings more than two rows back are defined as sheltered.

Step 2 – In a lee zone?

Determine if the site is in a lee zone. These are shown as hatched areas in Figure 5.1. Lee zones may have higher wind speeds.

Step 3 – Ground roughness

Determine the ground roughness from the two options defined by NZS 3604 paragraph 5.2.3:

- Urban terrain – more than 10 obstructions over 3 m high, such as houses or trees, per hectare.
- Open terrain – open areas with only isolated trees or shelter, such as adjacent to fields or beaches and open bodies of water.

Generally, any built-up residential area (see Figure 5) or any forested area will be defined as urban. A site adjacent to farmland or other open space will be defined as open terrain.

Where a site is within 500 m of the boundary between urban and open terrain, it must be considered as open terrain.

Step 4 – Site exposure

Determine site exposure from the two options in paragraph 5.2.4:

- Sheltered – a site surrounded by at least two rows of obstructions that are permanent, similar in size and at the same ground level.
- Exposed – a site that is steep (as defined in Table 5.2) or adjacent to an open space such as a playing field (see Figure 6) or beach or adjacent to a wind channel that is more than 100 m wide.

Comment C5.2.4 states that typical suburban developments on flat or near-flat ground are generally classified as sheltered (see Figure 5).

Table 1

PROCEDURE FOR DETERMINATION OF WIND ZONES

(NZS 3604:2011 TABLE 5.1, PROVIDED BY STANDARDS NEW ZEALAND UNDER LICENCE 001083.)

STEPS	ACTION	REFERENCE	VALUES AVAILABLE
1	Determine wind region	Figure 5.1	A, W
2	Determine if in a lee zone	Figure 5.1	See Table 5.4
3	Determine ground roughness	Paragraph 5.2.3	Urban terrain Open terrain
4	Determine site exposure	Paragraph 5.2.4	Sheltered, exposed
5	Determine topographic class	From Tables 5.2, 5.3 and Figure 5.2	Gentle to steep
6	Determine wind zone	Table 5.4	L, M, H, VH, EH

Step 5 – Topographic class

Determine the topographic class (T1–T4), from Table 5.2 and Figure 5.2 (see Figure 7).

This consists of a number of steps (see Table 5.2):

- If not flat ground, determine if the ground is:
    - a hill – land rises to a crest or high point then falls again on the other side
    - an escarpment – a steep slope or cliff separating two relatively level regions of ground that are at different elevations. Note that NZS 3604 5.2.5 defines an escarpment as the region beyond a crest where the gradient is less than 1 in 20.
- Next, determine the smoothed gradient from Figure 5.2. This requires the gradients of the upper part of the hill to be considered:
    - The smoothed gradient of the hill is assessed over the horizontal upwind distance between the crest of the hill and the lesser of three times the height of the hill (H) or 500 m (L).
    - The smoothed gradient is the elevation (h) divided by the relevant distance (L). ➤

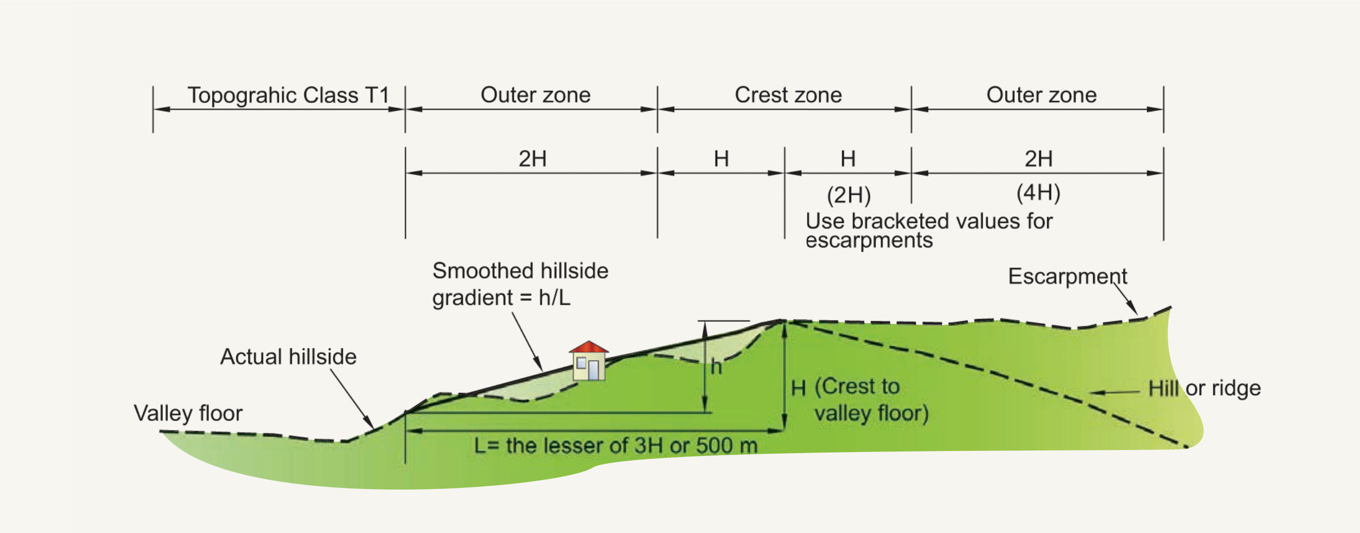


Figure 7 **Topography (including escarpment conditions). NZS 3604:2011 Figure 5.2. (Provided by Standards New Zealand under licence 001083.)**

Example 1:

H (height of hill from crest to valley floor) = 180 m. L = the lesser of 3H or 500 m, 3H = 540, so L is 500 m.

So, if h (elevation of the site) = 100 m, h/L = 100/500 = 0.2 or 1:5. Therefore, the gradient of the site is 'steep' (from Table 5.2).

Or if h = 50 m, h/L = 50/500 = 0.1 or 1:10. Therefore, the gradient of the site is 'low' (from Table 5.2).

- Determine the location of the site as T1 (valley floor), outer zone or crest zone. In example 1, the building is located 250 m from the crest of the hill, which is more than H (= 180 m) so it is outside the crest zone. However, it is within the outer zone (<500 m).
- The topographic class (T) must be determined from Table 5.3. In example 1, with steep gradient in outer zone, the topographic class is T3; with the low gradient in outer zone, the topographic class is T1.

If the site does not fall within an outer or crest zone, it is classified as T1, but there are some exceptions.

Step 6 – Now find wind zone

It is now possible to determine the wind zone from Table 5.4 using the information gathered – wind region, ground roughness, topographic class and site exposure.

Example 2:

From Table 5.4, a site in region W classified as T4 (moderate crest zone), urban and exposed, is in wind zone EH (extra high wind speed – maximum 55 m/s).

Calculate wind bracing demand

The wind zone can now be applied to calculate the wind bracing demand from NZS 3604:2011, Tables 5.5, 5.6 and 5.7. These tables give wind bracing demands (BU/m) for the subfloor structure and the walls of single and upper floors and the lower of two-storeys.

Where the zone is not high (H), the multiplier for the relevant wind zone is used to calculate the correct wind bracing demand.

Where wind zone is above extra high (from Table 5.4), the wind zone is SED or specific engineering design and is beyond the scope of NZS 3604.

4 Topographic zones

A READER ASKS, 'HOW DO THE NZS 3604:2011 TOPOGRAPHIC ZONES WORK?'. WITH MORE BUILDINGS BEING CONSTRUCTED ON EXPOSED SITES, THIS IS AN IMPORTANT QUESTION TO UNDERSTAND.

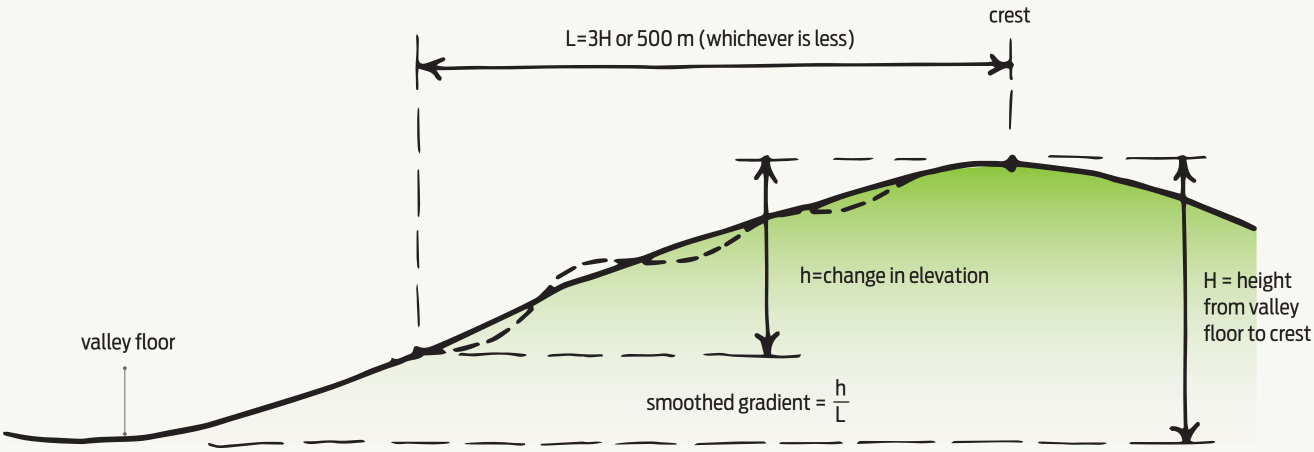


Figure 8 Smoothed gradient.

WE ALL KNOW from experience that hilltops (and other exposed locations) have higher wind speeds than the valley floor, and the topographic classes T1 to T4 are a measure of just how much higher.

Start with shape of ground

The first step is to stand back and get an overall picture of the shape of the ground surrounding the site. Don't get into too much detail. This is big picture stuff and is best done by a site visit.

Most of New Zealand's hill country is 'spur/gully' formation where the land drops away on both sides of a hilltop, ridge or spur. This is a 'hill shape' in NZS 3604-speak.

However, around the coasts or beside large river valleys, there are often 'escarpments' where the water has cut away one side of the hill and the other side is relatively flat. Note that if the ground comprises undulations of less than 10 m (height of a 3-storey house) or is flatter than 1:20, the topographic class is T1.

Then smoothed gradient

The next step is to determine the slope of the hill or 'smoothed gradient'. This is also big picture stuff, and contours from a typical site survey will rarely extend far enough. The best source of information is a large-scale contour map or an online tool such as Google Earth.

The hill slope is measured over either:

- a distance from the hill crest of 3 × height of the crest above the valley floor (H), or
- 500 m, whichever is less.

Figure 5.2 of NZS 3604:2011 *Timber-framed buildings* is misleading here, and an alternative is given in Figure 8.

The smoothed gradient is h/L. Where the distance L extends from the crest up the next hill, as can sometimes happen in steeper country (see Figure 9), take L as the distance to the valley floor.

Position of building

Next consider the position of the building site in relation to the crest of the hill (or escarpment):

- If it is within distance H (or 2H downwind for an escarpment), it is in the 'crest zone' where wind acceleration is a maximum.
- If it is between 1H and 3H from the crest (or between 2H and 6H downwind for an escarpment), it is within the 'outer zone'.
- If it is more than 3H (or 6H for an escarpment), it is T1 because wind acceleration is not significant.

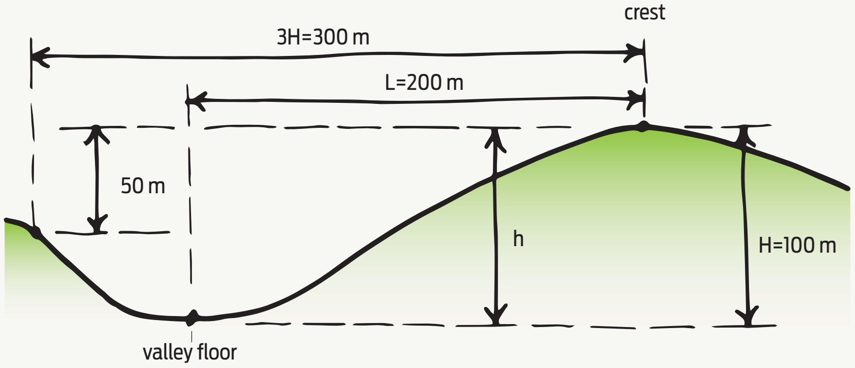
See Figures 10 and 11.

Note that row 4 in NZS 3604 Table 5.2 is irrelevant for topographic class and should be ignored – it fits into Table 5.4.

Note also that the entry for 'steep' in Table 5.2 should have no upper limit.

Now the topographic class

Finally, the topographic class T1 to T4 is determined from Table 5.3 using the information determined above.



In this example, smoothed gradient should be:

100/200 = 0.5 = steep **NOT** 50/300 = 0.17 = moderate

Figure 9 **Determining topographic zone in steep hillside.**

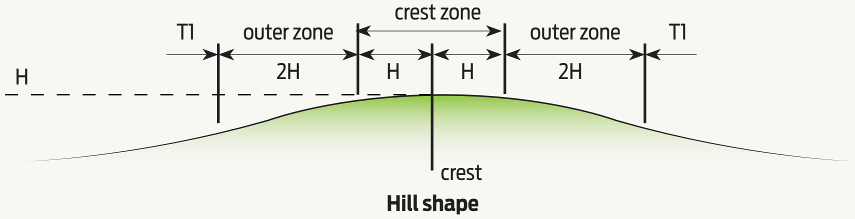


Figure 10 **Building sites adjacent to a crest.**

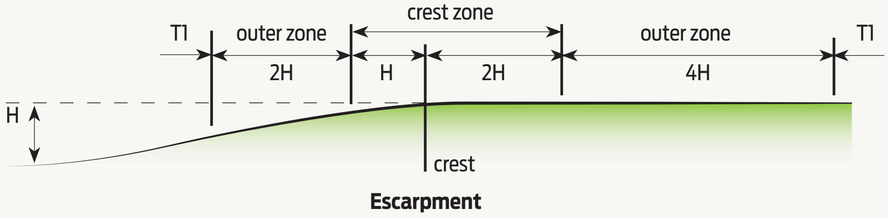


Figure 11 **Building sites adjacent to an escarpment.**

5

Subfloor bracing

NEXT WE WORK THROUGH THE BRACING CALCULATIONS FOR A SUBFLOOR EXAMPLE.

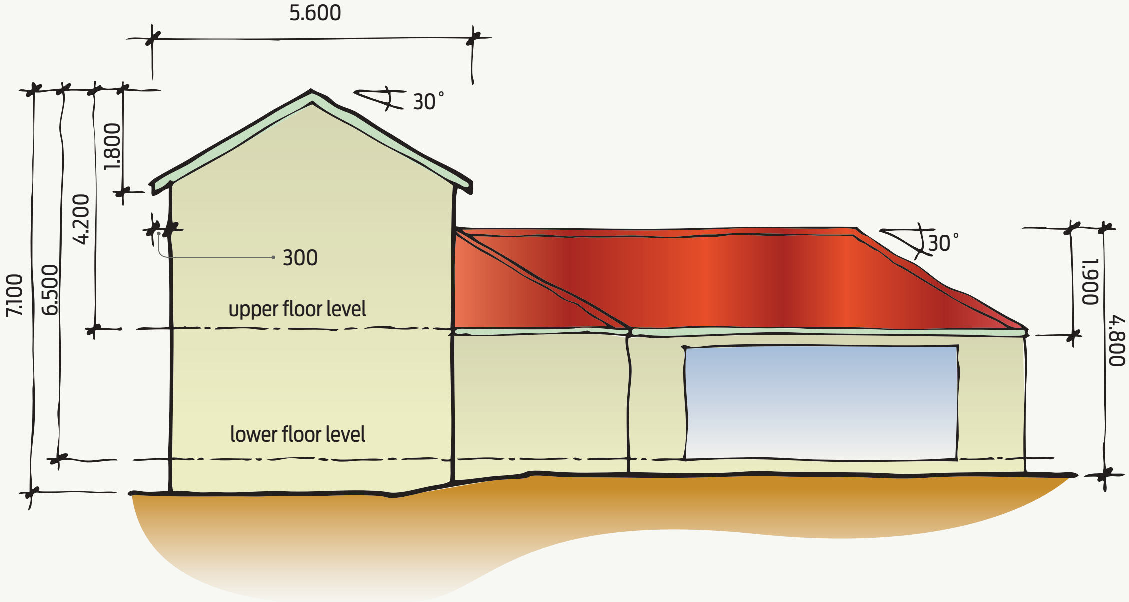


Figure 12 Elevation of example house.

THE HOUSE BEING USED in this example has a second storey on part of the house (see Figures 12–13).

Data for this example

Refer to pages 4–6 for how to establish these values.

Wind zone: Medium

Earthquake zone: 2

Floor plan area

This example has a mixture of single and double storeys. Because these have different wind and earthquake demands, two calculations are required – one for the subfloor area of the 2-storey portion and one for the subfloor area of the single-storey (shown in Figure 14). The slab floor in the garage has no subfloor so does not form part of the calculation.

Gross floor plan area for:

2-storey = 10.6 × 5 = 53 m^2

1-storey = 8.1 × 9.3 = 75.3 m^2 (for simplicity, the area has not been reduced for the entry porch).

Once the demand is established, the overlap of the 2-storey will be deducted from the 1-storey.

Soil type: Rock

Weight of claddings: Light subfloor, lower storey, upper storey and roof

Roof pitch: 30 degrees, so choose 25–45 degrees

Building shape: Subfloor has no wings or blocks

Heights for building

2-storey to apex H = 7.1 m, roof height above eaves h = 1.8 m.

Note: Where heights don't exactly match the table, use the next highest bracing unit (BU). For example, in the subfloor structure (using Table 5.5), H = 7.1 m, so round up to 8 m, and h = 1.8 (round down to 1 m, this is a higher BU requirement).

Single-storey to apex H = 4.8 m, h = 1.9 m.

Roof type and building dimension

The 2-storey has a gable roof with 300 mm soffit/verge.

As the roof is over 25^{0}, when considering wind on the 2-storey part of the building, use the overall dimensions of the roof for the width and length.

So, 2-storey section building dimensions are:

Length = 10.6 + 0.300 + 0.300 = 11.2 m

Width = 5.0 + 0.300 + 0.300 = 5.6 m.

Single-storey dimensions are:

Length = 9.3 m (no soffit to lower level)

Width = 8.1 m (no soffit to lower level).

Transfer these values to the calculation sheets (Figures 15 and 17).

Note that, because this is a hip roof shape, wind demand in both the along and across directions is the same, so choice of length and width is not critical.

Bracing calculation sheets

The above data is then entered into bracing calculation sheets to obtain the bracing demand (see Figures 15 and 17). Sheets can be downloaded from the Toolbox on the BRANZ website www.branz.co.nz.

2-storey section

Using the calculation sheets (see Figure 15), bracing demand for the 2-storey section is:

- 1176 BUs for wind across the ridge
- 627 BUs for wind along the ridge
- 636 BUs for earthquake.

Use 1176 BUs for wind across and 636 for both wind along and earthquake.

Single-storey section

Bracing demand results for the single-storey area (see Figure 17) are:

- 521 BUs for wind across
- 454 BUs for wind along
- 603 BUs for earthquake.

Use 603 BUs for along and across as it is the higher value in both directions.

Choose bracing element

The subfloor is 600 mm or less high. Anchor piles have been chosen as the subfloor bracing element as they are rated as 160 BUs for wind and 120 BUs for earthquake.

Moving to the bracing lines

For this example, the exterior walls will be used as bracing lines in each direction along with the common wall between the garage and the house. These are within the 5 m rule and provide an even distribution of bracing throughout the building.

We now need to calculate the minimum bracing needed in each line and check the bracing distribution complies with the requirements of NZS 3604:2011 clause 5.5:

- maximum spacing of bracing lines in the subfloor = 5 m ➤

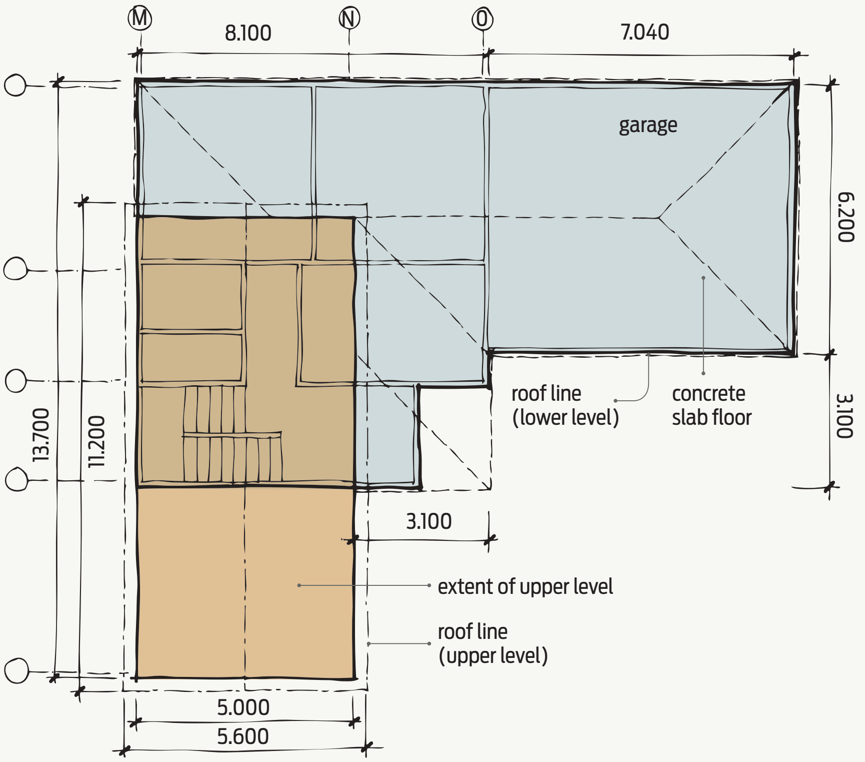


Figure 13 Floor plan of example house.

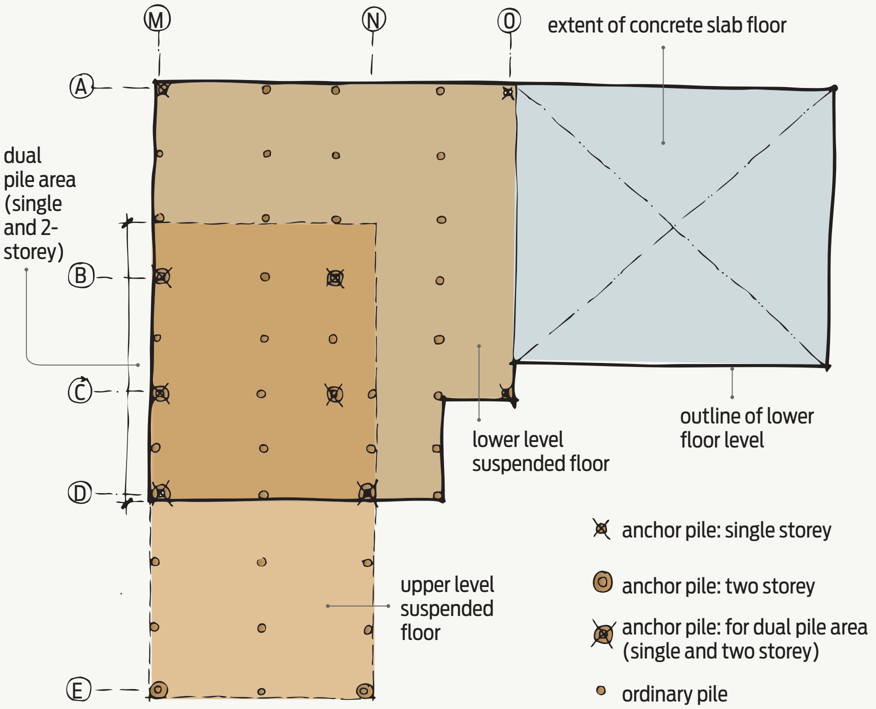
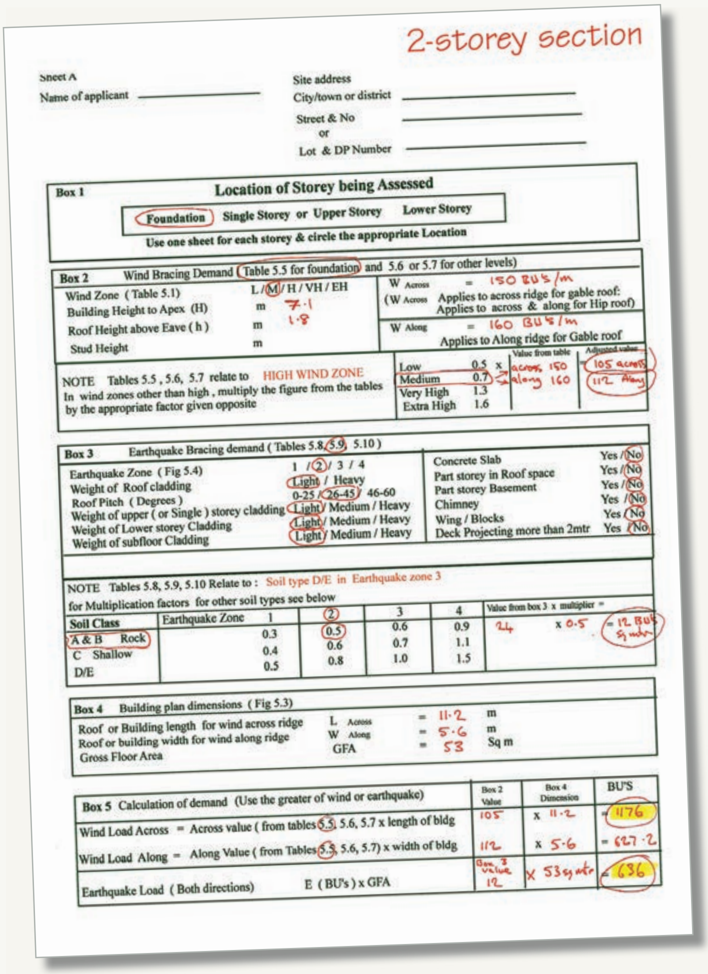


Figure 14 Foundation plan.



2-storey section

Sheet A
Name of applicant ______
Site address
City/town or district ______
Street & No ______
or
Lot & DP Number ______

Box 1 Location of Storey being Assessed
[✓ Foundation] Single Storey or Upper Storey Lower Storey
Use one sheet for each storey & circle the appropriate Location

Box 2 Wind Bracing Demand ([✓ Table 5.5 for foundation] and 5.6 or 5.7 for other levels)
Wind Zone (Table 5.1) L / [✓ M] / H / VH / EH
Building Height to Apex (H) m 7·1
Roof Height above Eave (h) m 1·8
Stud Height m
W Across = 150 BU's/m
(W Across Applies to across ridge for gable roof: Applies to across & along for Hip roof)
W Along = 160 BU's/m Applies to Along ridge for Gable roof

NOTE Tables 5.5, 5.6, 5.7 relate to HIGH WIND ZONE
In wind zones other than high, multiply the figure from the tables by the appropriate factor given opposite

			Value from table		Adjusted value
Low	0.5	x	across 150	=	105 across
[✓ Medium]	0.7		along 160		112 Along
Very High	1.3				
Extra High	1.6				

Box 3 Earthquake Bracing demand (Tables 5.8, [✓ 5.9], 5.10)
Earthquake Zone (Fig 5.4) 1 / [✓ 2] / 3 / 4
Weight of Roof cladding [✓ Light] / Heavy
Roof Pitch (Degrees) 0-25 / [✓ 26-45] / 46-60
Weight of upper (or Single) storey cladding [✓ Light] / Medium / Heavy
Weight of Lower storey Cladding [✓ Light] / Medium / Heavy
Weight of subfloor Cladding [✓ Light] / Medium / Heavy
Concrete Slab Yes / [✓ No]
Part storey in Roof space Yes / [✓ No]
Part storey Basement Yes / [✓ No]
Chimney Yes / [✓ No]
Wing / Blocks Yes / [✓ No]
Deck Projecting more than 2mtr Yes / [✓ No]

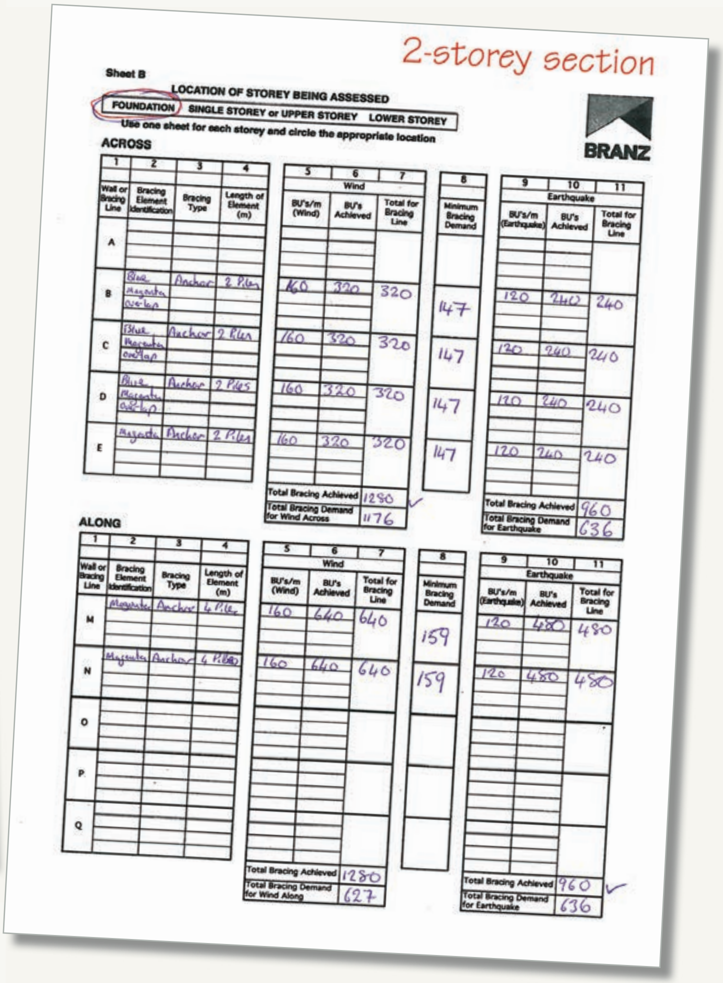
NOTE Tables 5.8, 5.9, 5.10 Relate to : Soil type D/E in Earthquake zone 3
for Multiplication factors for other soil types see below

Soil Class	Earthquake Zone 1	[✓ 2]	3	4	Value from box 3 x multiplier =
[✓ A & B Rock]	0.3	[✓ 0.5]	0.6	0.9	24 x 0.5 = 12 BU's Sq mtr
C Shallow	0.4	0.6	0.7	1.1	
D/E	0.5	0.8	1.0	1.5	

Box 4 Building plan dimensions (Fig 5.3)
Roof or Building length for wind across ridge L Across = 11·2 m
Roof or building width for wind along ridge W Along = 5·6 m
Gross Floor Area GFA = 53 Sq m

Box 5 Calculation of demand (Use the greater of wind or earthquake)	Box 2 Value	Box 4 Dimension	BU'S
Wind Load Across = Across value (from tables [✓ 5.5], 5.6, 5.7 x length of bldg	105	x 11·2	= 1176
Wind Load Along = Along Value (from Tables [✓ 5.5], 5.6, 5.7) x width of bldg	112	x 5·6	= 627·2
Earthquake Load (Both directions) E (BU's) x GFA	Box 3 value 12	x 53 sq mtr	= 636

Figure 15 Calculation sheet for demand – 2-storey section of subfloor.



2-storey section

Sheet B
LOCATION OF STOREY BEING ASSESSED
[✓ FOUNDATION] SINGLE STOREY or UPPER STOREY LOWER STOREY
Use one sheet for each storey and circle the appropriate location

ACROSS

1	2	3	4	5	6	7	8	9	10	11
					Wind				Earthquake	
Wall or Bracing Line	Bracing Element Identification	Bracing Type	Length of Element (m)	BU's/m (Wind)	BU's Achieved	Total for Bracing Line	Minimum Bracing Demand	BU's/m (Earthquake)	BU's Achieved	Total for Bracing Line
A										
B	Blue Magenta over-lap	Anchor	2 Piles	160	320	320	147	120	240	240
C	Blue Magenta overlap	Anchor	2 Piles	160	320	320	147	120	240	240
D	Blue Magenta over-lap	Anchor	2 Piles	160	320	320	147	120	240	240
E	Magenta	Anchor	2 Piles	160	320	320	147	120	240	240

Total Bracing Achieved 1280 ✓
Total Bracing Demand for Wind Across 1176
Total Bracing Achieved 960
Total Bracing Demand for Earthquake 636

ALONG

1	2	3	4	5	6	7	8	9	10	11
					Wind				Earthquake	
Wall or Bracing Line	Bracing Element Identification	Bracing Type	Length of Element (m)	BU's/m (Wind)	BU's Achieved	Total for Bracing Line	Minimum Bracing Demand	BU's/m (Earthquake)	BU's Achieved	Total for Bracing Line
M	Magenta	Anchor	4 Piles	160	640	640	159	120	480	480
N	Magenta	Anchor	4 Piles	160	640	640	159	120	480	480
O										
P										
Q										

Total Bracing Achieved 1280
Total Bracing Demand for Wind Along 627
Total Bracing Achieved 960 ✓
Total Bracing Demand for Earthquake 636

Figure 16 Calculation sheet for bracing achieved – 2-storey section of subfloor.

- minimum capacity of subfloor bracing lines is the greater of:
  - 100 BUs
  - 15 BU/m of bracing line
  - 50% of the total bracing demand, divided by the number of bracing lines in the direction being considered.

See Table 2 where this has been worked through.

Minimum bracing for 2-storey section

Using the calculation sheet (see Figure 16) gives:

- 1280 BUs for wind across
- 960 BUs for earthquake and along.

This meets the minimum demand requirements from the calculation sheet (see Figure 15) and NZS 3604:2011 clause 5.5.2.

Minimum bracing for single-storey section

Using the calculation sheet (see Figure 18) gives:

- 1080 BUs for earthquake bracing across
- 1080 BUs for earthquake bracing along.

This meets the minimum demand requirements from the calculation sheet (see Figure 17) and NZS 3604 clause 5.5.2.

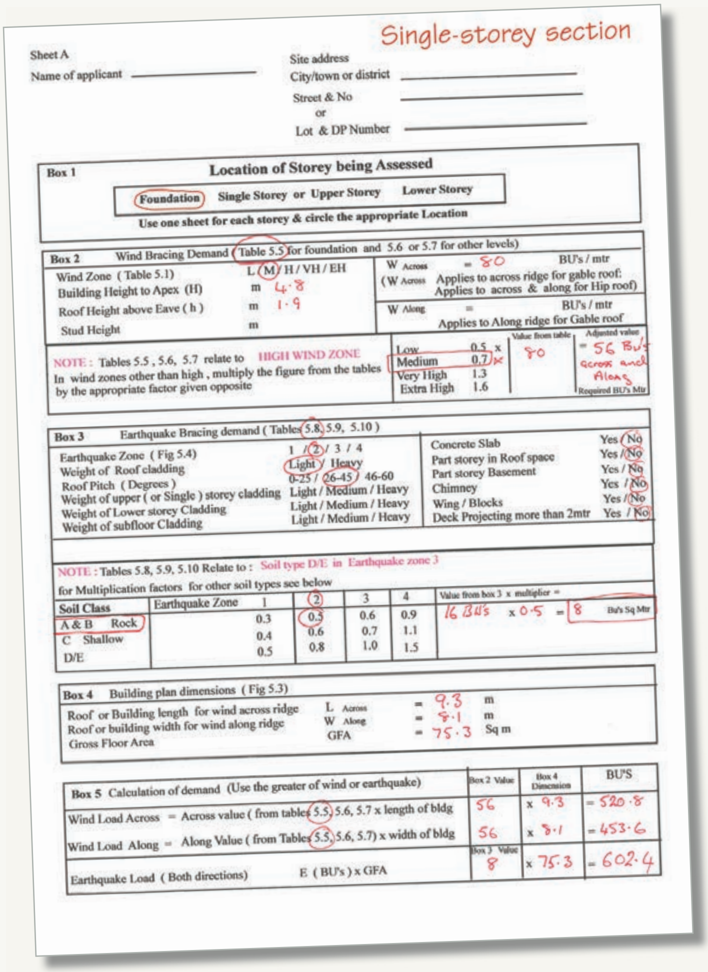
The piles in brace line N are staggered to comply with the requirement that braced or load-bearing walls are within 200 mm of the pile line.

More to check

Buildings where the height exceeds 1.7 times the width must be on a continuous foundation wall (NZS 3604:2011 clause 5.4.3.2). Height is measured from the underside of the bottom plate on the lowest floor to the top of the roof). In this example, width 5 m × 1.7 = 8.5 m, so this design is OK as the height is 6.5 m from underside of bottom plate to top of roof.

There is also a minimum number of subfloor braces (NZS 3604:2011 clause 5.5.6) – a minimum of four braced or anchor piles placed in each direction symmetrically around the perimeter. Wherever practical, they should be placed near a corner. This design has five piles in the across direction and nine in the along direction so is OK.

Note **Having trouble reading Figures 15–18? You can download these with this article from www.buildmagazine.co.nz then The Right Stuff.** ◀



Single-storey section

Sheet A

Name of applicant ____

Site address

City/town or district ____

Street & No ____

or

Lot & DP Number ____

Box 1 **Location of Storey being Assessed**

[✓ Foundation] Single Storey or Upper Storey Lower Storey

Use one sheet for each storey & circle the appropriate Location

Box 2 Wind Bracing Demand ([✓ Table 5.5] for foundation and 5.6 or 5.7 for other levels)

Wind Zone (Table 5.1) L / [✓ M] / H / VH / EH

Building Height to Apex (H) m 4·8

Roof Height above Eave (h) m 1·9

Stud Height m

W Across = 80 BU's / mtr

(W Across Applies to across ridge for gable roof: Applies to across & along for Hip roof)

W Along = BU's / mtr

Applies to Along ridge for Gable roof

NOTE : Tables 5.5 , 5.6, 5.7 relate to HIGH WIND ZONE In wind zones other than high , multiply the figure from the tables by the appropriate factor given opposite

		Value from table	Adjusted value Required BU's Mtr
Low	0.5 x	80	= 56 BU's across and Along
[✓ Medium]	0.7 x		
Very High	1.3		
Extra High	1.6		

Box 3 Earthquake Bracing demand (Tables [✓ 5.8], 5.9, 5.10)

Earthquake Zone (Fig 5.4) 1 / [✓ 2] / 3 / 4

Weight of Roof cladding [✓ Light] / Heavy

Roof Pitch (Degrees) 0-25 / [✓ 26-45] / 46-60

Weight of upper (or Single) storey cladding Light / Medium / Heavy

Weight of Lower storey Cladding Light / Medium / Heavy

Weight of subfloor Cladding Light / Medium / Heavy

Concrete Slab Yes / [✓ No]

Part storey in Roof space Yes / [✓ No]

Part storey Basement Yes / [✓ No]

Chimney Yes / [✓ No]

Wing / Blocks Yes / [✓ No]

Deck Projecting more than 2mtr Yes / [✓ No]

NOTE : Tables 5.8, 5.9, 5.10 Relate to : Soil type D/E in Earthquake zone 3

for Multiplication factors for other soil types see below

Soil Class	Earthquake Zone 1	[✓ 2]	3	4	Value from box 3 x multiplier =
[✓ A & B Rock]	0.3	[✓ 0.5]	0.6	0.9	16 BU's x 0·5 = 8 Bu's Sq Mtr
C Shallow	0.4	0.6	0.7	1.1	
D/E	0.5	0.8	1.0	1.5	

Box 4 Building plan dimensions (Fig 5.3)

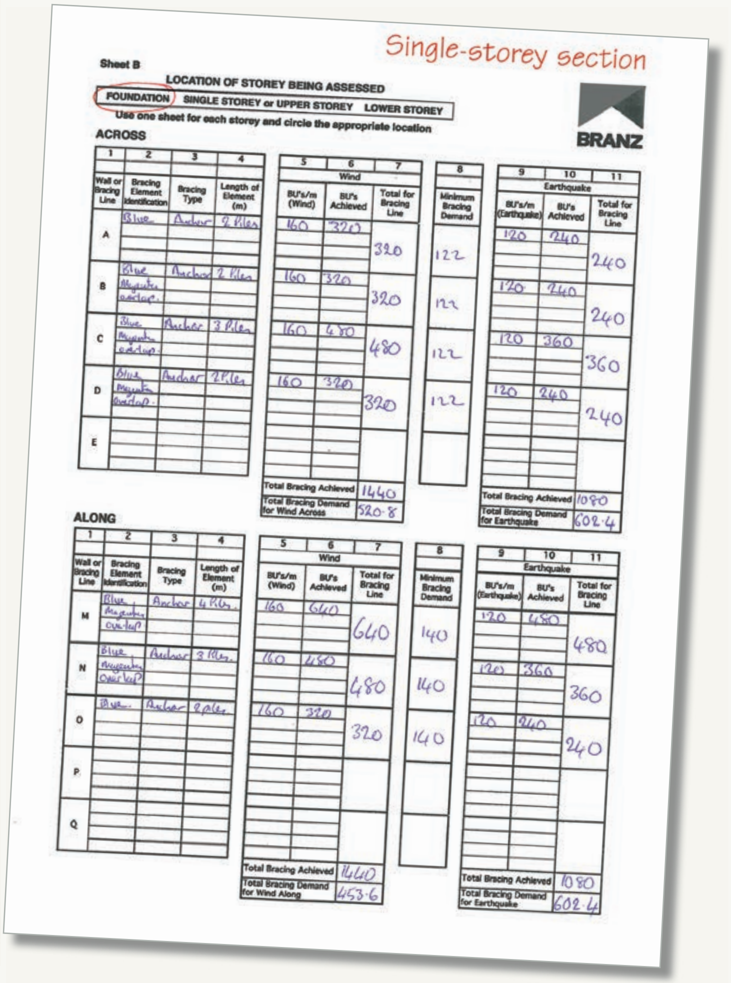
Roof or Building length for wind across ridge L Across = 9·3 m

Roof or building width for wind along ridge W Along = 8·1 m

Gross Floor Area GFA = 75·3 Sq m

Box 5 Calculation of demand (Use the greater of wind or earthquake)	Box 2 Value	Box 4 Dimension	BU'S
Wind Load Across = Across value (from tables [✓ 5.5], 5.6, 5.7 x length of bldg	56	x 9·3	= 520·8
Wind Load Along = Along Value (from Tables [✓ 5.5], 5.6, 5.7) x width of bldg	56	x 8·1	= 453·6
	Box 3 Value		
Earthquake Load (Both directions) E (BU's) x GFA	8	x 75·3	= 602·4

Figure 17 Calculation sheet for demand – single-storey section of subfloor.



Single-storey section

Sheet B

LOCATION OF STOREY BEING ASSESSED

[✓ FOUNDATION] SINGLE STOREY or UPPER STOREY LOWER STOREY

Use one sheet for each storey and circle the appropriate location

ACROSS

1	2	3	4	5	6	7	8	9	10	11
				Wind				Earthquake		
Wall or Bracing Line	Bracing Element Identification	Bracing Type	Length of Element (m)	BU's/m (Wind)	BU's Achieved	Total for Bracing Line	Minimum Bracing Demand	BU's/m (Earthquake)	BU's Achieved	Total for Bracing Line
A	Blue	Anchor	2 Piles	160	320	320	122	120	240	240
B	Blue Magenta overlap	Anchor	2 Piles	160	320	320	122	120	240	240
C	Blue Magenta overlap	Anchor	3 Piles	160	480	480	122	120	360	360
D	Blue Magenta overlap	Anchor	2 Piles	160	320	320	122	120	240	240
E										

Total Bracing Achieved 1440

Total Bracing Demand for Wind Across 520·8

Total Bracing Achieved 1080

Total Bracing Demand for Earthquake 602·4

ALONG

1	2	3	4	5	6	7	8	9	10	11
				Wind				Earthquake		
Wall or Bracing Line	Bracing Element Identification	Bracing Type	Length of Element (m)	BU's/m (Wind)	BU's Achieved	Total for Bracing Line	Minimum Bracing Demand	BU's/m (Earthquake)	BU's Achieved	Total for Bracing Line
M	Blue Magenta overlap	Anchor	4 Piles	160	640	640	140	120	480	480
N	Blue Magenta overlap	Anchor	3 Piles	160	480	480	140	120	360	360
O	Blue	Anchor	2 piles	160	320	320	140	120	240	240
P										
Q										

Total Bracing Achieved 1440

Total Bracing Demand for Wind Along 453·6

Total Bracing Achieved 1080

Total Bracing Demand for Earthquake 602·4

Figure 18 Calculation sheet for bracing achieved – single-storey section of subfloor.

Table 2

MINIMUM BRACING NEEDED IN EACH LINE

	2-STOREY SECTION	SINGLE-STOREY SECTION
WIND ACROSS RIDGE		
Bracing lines	B, C, D and E = 5 m long	A, B, C, D = 8.1 m long
Bracing demand per line (greatest value)	100 BUs or 75 BUs (5.0 x 15 BUs) or **147** BUs (1176 BUs divided by 2 = 588 divided by 4 lines)	100 BUs or **122** BUs (8.1 x 15) or 76 BUs (603 BUs divided by 2 = 301.5 divided by 4 lines)
Minimum BUs per line	147 BUs	122 BUs
Minimum anchor piles per line	1 anchor pile = 160 BUs (wind)	2 anchor piles = 240 BUs (120 each for earthquake)
WIND ALONG RIDGE		
Bracing lines	M and N = 10.6 m long	M, N, O = 9.3 m long
Bracing demand per line (greater value)	100 BUs or **159** BUs (10.6 x 15) or **159** BUs (636 BUs (for earthquake) divided by 2 = 318 divided by 2 lines)	100 BUs or **140** BUs (9.3 x 15) or 100 BUs (603 BUs divided by 2 = 301.5 divided by 3 lines)
Minimum BUs per line	159 BUs	140 BUs
Minimum piles per line	2 anchor piles = 240 BUs (120 each for earthquake)	2 anchor piles = 240 BUs (120 each for earthquake)

6 Bracing for suspended floors

HERE ARE A FEW POINTERS FOR INTERPRETING NZS 3604:2011 BRACING PROVISIONS FOR BUILDINGS WITH SUSPENDED SUBFLOOR STRUCTURES.

DESIGNERS WILL HAVE NOTICED that there is a substantial increase in bracing demand from buildings on slabs to those on suspended floors. This ranges from about double the demand for walls of single-storey buildings to about a 30% increase in demand for walls of 2-storey buildings.

This increase is due to the additional seismic weight of the suspended floor and its contents (people, furniture and so on), and the greater effect of earthquake ground movements on suspended floors.

Experience from Christchurch

Observations in Christchurch after the earthquakes clearly showed that piled buildings with a perimeter foundation wall of concrete or concrete masonry performed very well, even when there was ground disturbance due to liquefaction and lateral spreading.

This is because of the bracing effect of the perimeter foundation wall, together with the floor acting as a diaphragm.

Gap in NZS 3604

NZS 3604:2011 provides two sets of tables for earthquake bracing demand:

- Table 5.10 for buildings built on a concrete slab.
- Tables 5.8 and 5.9 for buildings on a suspended floor structure.

However, NZS 3604 makes no distinction between fully piled suspended substructures and those with a concrete or masonry perimeter foundation.

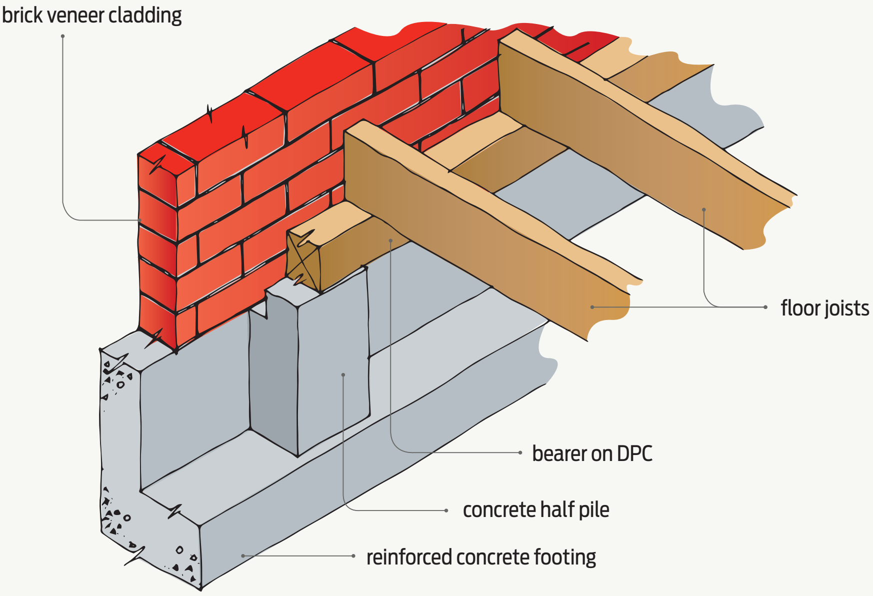


Figure 19 Suspended floor structure with semi-detached or half pile.

Bracing design advice

After discussions with practitioners, BRANZ advises:

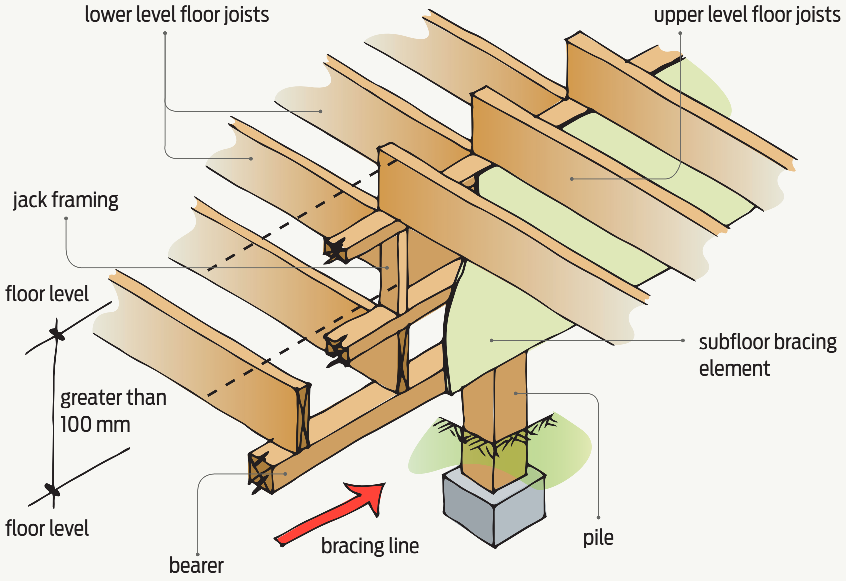
- if the building is on a slab, use NZS 3604 Table 5.10
- if the building is all piled, use NZS 3604 Table 5.8 (single-storey) or 5.9 (two-storey)
- if the suspended floor structure is well connected to the perimeter foundation (as required by NZS 3604 Figure 6.17 for bearers and Figure 6.16 for wall plates), treat it as a slab and use Table 5.10
- if the suspended floor structure is not connected to the perimeter foundation (for example, the semi-detached pile in Figure 19 – a common construction detail for older timber-framed buildings), then conservatively Table 5.8 or 5.9 should be used. Structural engineers experienced in timber-framed construction could perhaps justify a demand value between those from Tables 5.8/5.9 and Table 5.10.

7 Bracing for steps in floors or ceilings

BRACING REQUIREMENT RULES ARE A LITTLE DIFFERENT FOR DISCONTINUOUS FLOORS OR CEILINGS.

NZS 3604:2011 clause 5.15 has the bracing requirements for buildings with a step or break greater than 100 mm in the finished levels. This requires:

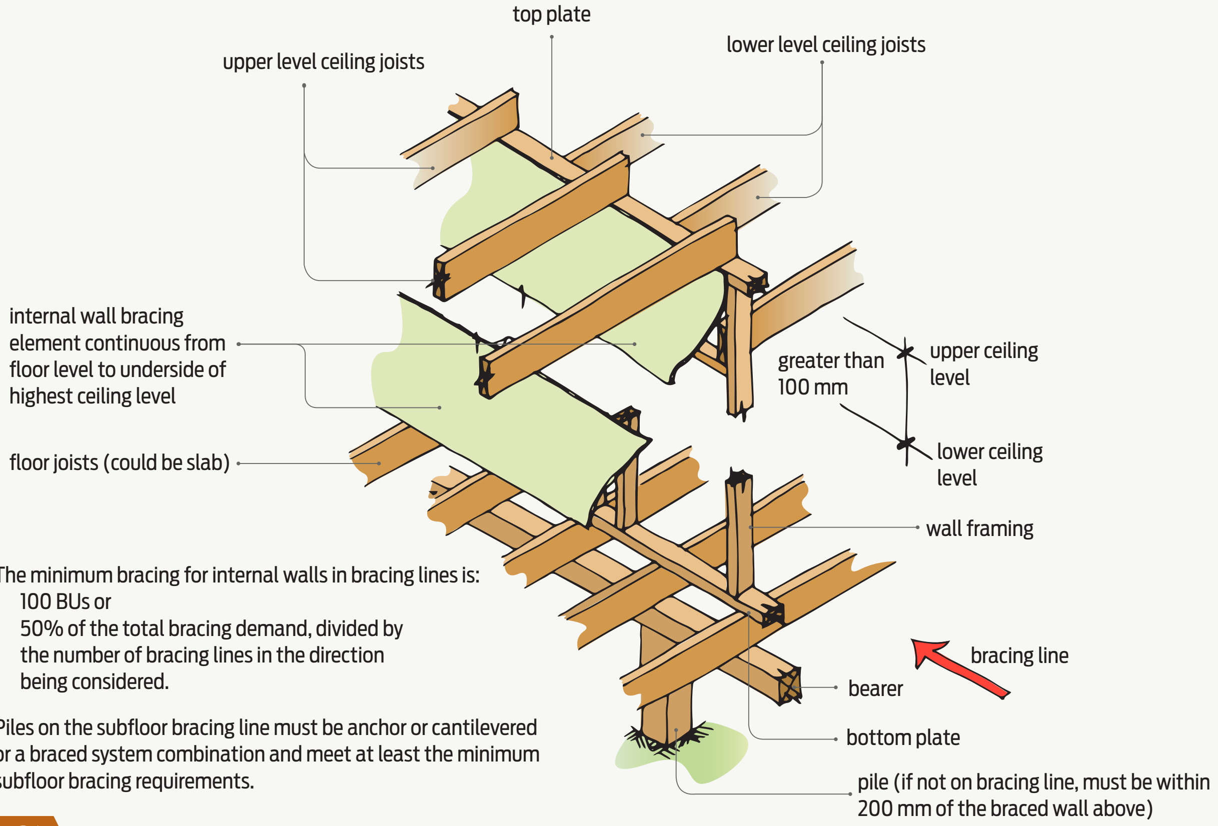
- a bracing line in the storey below, directly under the discontinuity, and
- the bracing elements in the storey below must be continuous from floor level to the underside of the highest ceiling level (see Figures 20 and 21).



Piles need to be braced (anchor or cantilevered) and meet at least the minimum required bracing line capacity of:

- 100 BUs or
- 50% of the total bracing demand, divided by the number of bracing lines in the direction being considered.

Figure 20 Bracing design where floor is discontinuous.

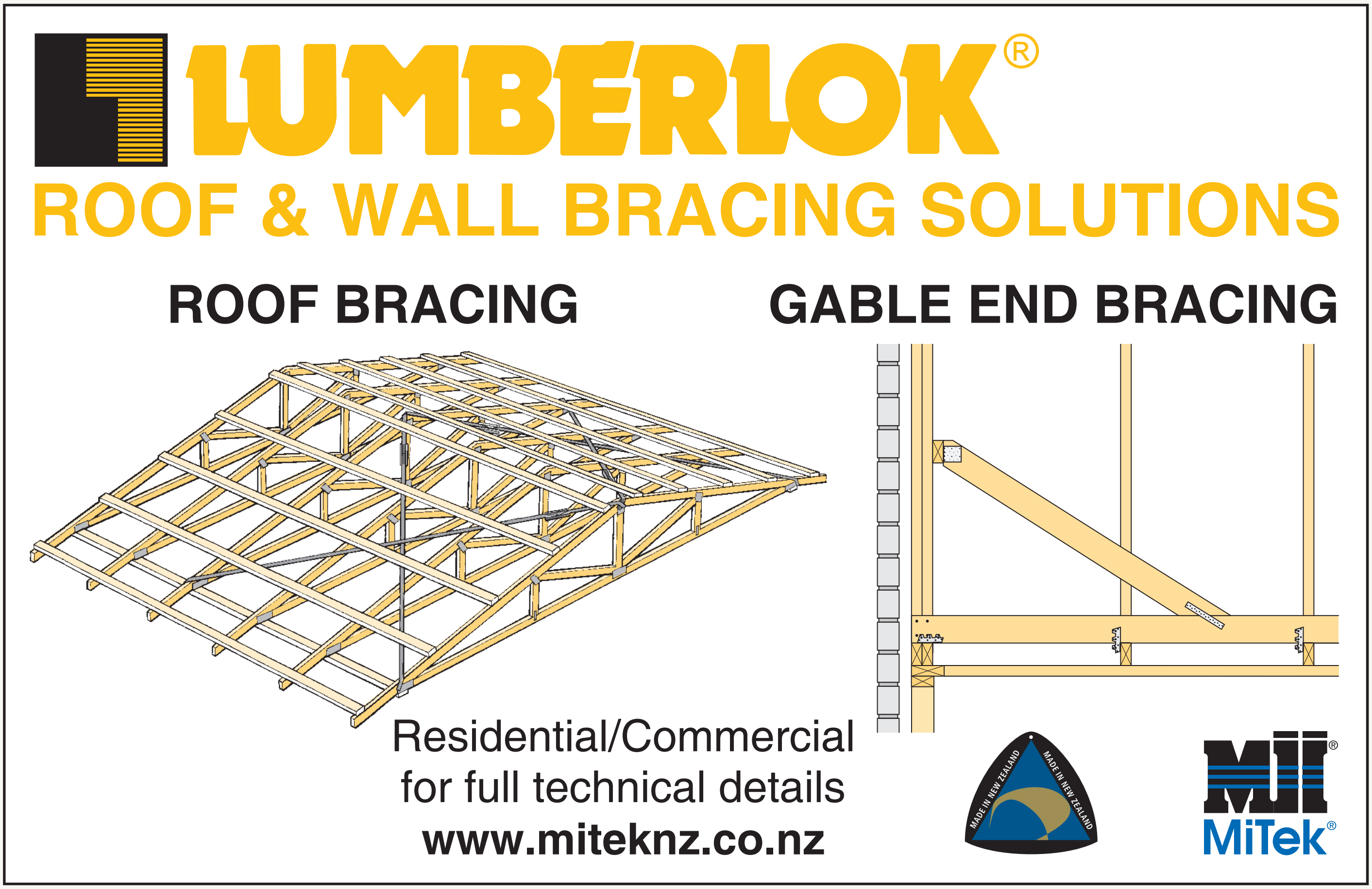


The minimum bracing for internal walls in bracing lines is:

- 100 BUs or
- 50% of the total bracing demand, divided by the number of bracing lines in the direction being considered.

Piles on the subfloor bracing line must be anchor or cantilevered or a braced system combination and meet at least the minimum subfloor bracing requirements.

Figure 21 **Bracing design where ceiling is discontinuous.**



8 Wall bracing

NEXT UP, WE LOOK AT CALCULATING WALL BRACING REQUIREMENTS FOR A BUILDING.

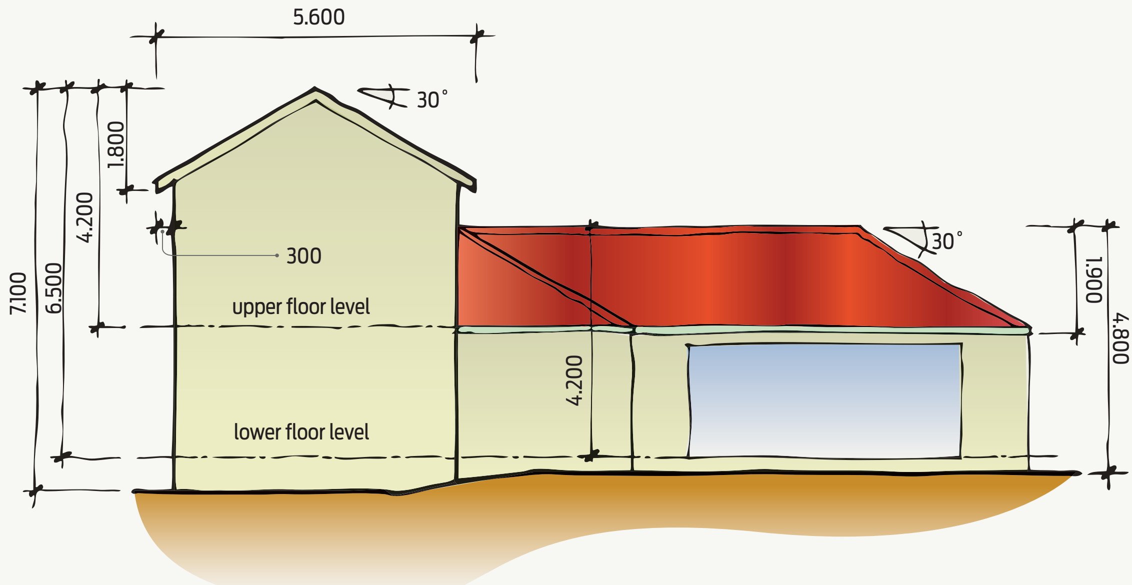


Figure 22 Elevation of example house.

THE SAME BUILDING is being used as for the sub-floor bracing (see pages 14–17) with additional information in Figures 22 and 23.

Data for calculation sheets for this example

Wind zone: Medium

Earthquake: Zone 2

Floor plan areas

The example building is part 2-storey, part single-storey. The garage is on a slab, and the remainder has a subfloor.

Because these have different wind and earthquake demands, the building is divided into four areas – upper of 2-storey, lower of 2-storey, single-storey and garage – and four calculations are needed, one for each of these.

The gross floor plan area for the:

- 2-storey = 10.6 × 5.0 = 53 m²
- 1-storey = 8.1 × 9.3 = 75.3 m² (for simplicity, the area has not been reduced for the porch entry)
- garage area = 6.2 × 7.040 = 43.6 m²

Soil type: Rock

Cladding weights: Light lower storey, upper storey and roof

Roof pitch: 30 degrees, so choose 25–45 degrees

Heights for building:

- Lower of 2-storey to apex H = 6.5 m, h = 1.8 m
- Upper storey to apex H = 4.2 m, h = 1.8 m
- 1-storey to apex H = 4.8 m, h = 1.9 m
- Garage to apex H = 4.8 m, h = 1.9 m

Roof type and building dimension

As the roof pitch is over 25 degrees, when considering wind for the 2-storey part of the building, use the overall dimensions of the roof width and length.

So, 2-storey section (upper and lower levels) are:

- length = 10.6 + 0.300 + 0.300 = 11.2 m
- width = 5.0 + 0.300 + 0.300 = 5.6 m
- single-storey: length = 6.2 + 3.1 = 9.3 m, width = 8.1 m (no roof overhangs)
- garage: length = 7.040 m, width = 6.2 m (no roof overhangs).

Bracing lines and spacings

Use the same bracing layout as for the subfloor on page 15 (see Figures 23 and 28).

For simplicity, the bracing demand for the 1-storey area has not had the area of overlap with the 2-storeys deducted. Blue entries in Figure 26 indicate overlap of demand.

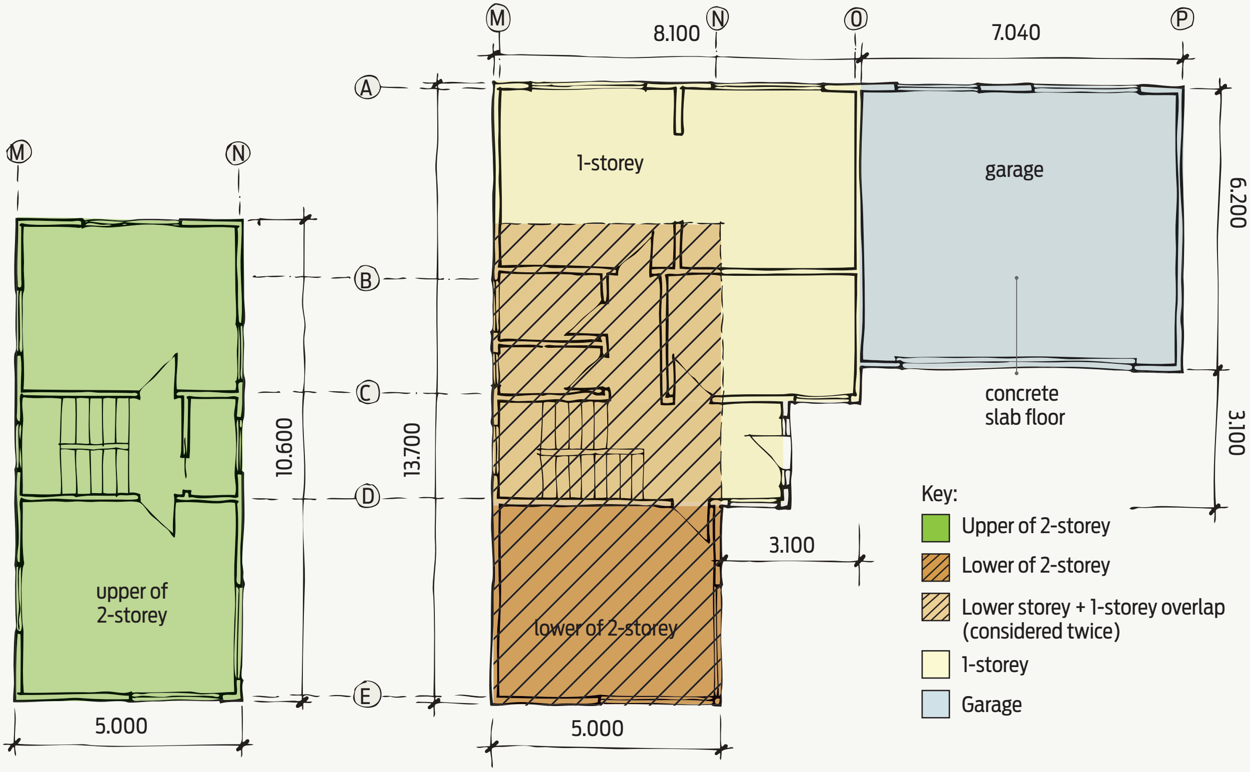


Figure 23 **Floor plan of example house.**

The maximum allowed spacing of bracing lines for walls is 6 m (NZS 3604:2011 clause 5.4.6).

The garage bracing lines are greater than 6 m apart so the garage will require a diaphragm ceiling. Diaphragm ceiling requirements are covered in NZS 3604:2011 clause 13.5 and minimum BUs requirements are in clause 5.6.2.

Alternatively, it may be possible to use dragon ties, which allow bracing lines spacing to be extended to 7.5 m. For walls with dragon ties attached, see clauses 8.3.3.1 to 8.3.3.4.

Bracing lines less than 1 m apart and parallel are considered to be in the same bracing line.

Wall bracing maximum ratings for attachment to:

- timber framed floors = 120 BUs/m
- concrete floors = 150 BUs/m.

See Figure 28 for the layout of the various braced sections.

Bracing demand per line

Complete the bracing calculation sheets (see Figures 24–27) to obtain bracing demand. Always use whichever has the higher demand for wind or earthquake – these have been highlighted in the calculation sheets as the minimum bracing demand required.

The minimum bracing demand per bracing line is the greater of:

- 15 BUs/m of bracing line or
- 100 BUs or
- 50% of the total demand, divided by the number of bracing lines in the direction being considered.

Minimum BUs per line in example

Lower level of the 2-storey (see Figure 24b):

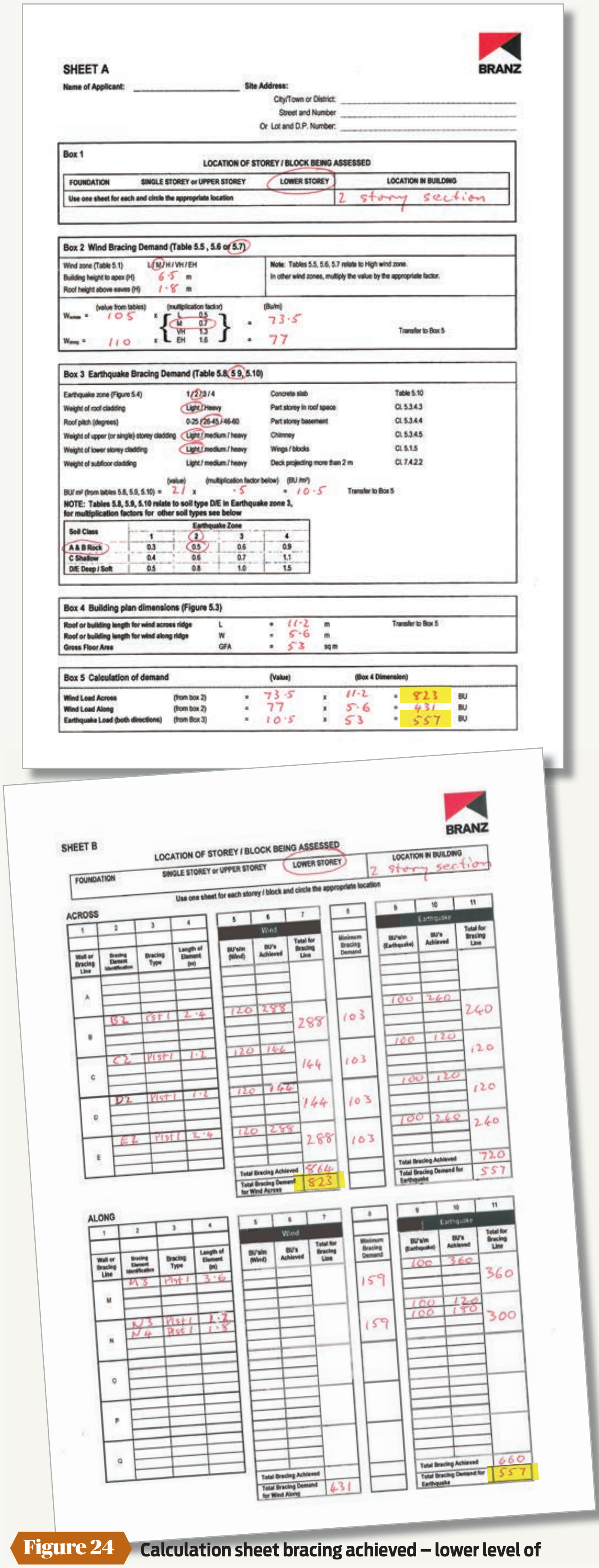
- Lines B, C, D, E = 5 m × 15 = 75 BUs or 100 BUs or 824/2 divided by 4 lines = **103 BUs**
- Lines M, N = 10.6 × 15 = **159 BUs** or 100 BUs or 557/2 divided by 2 lines = 139.2 BUs

Upper level of 2-storey (see Figure 25b):

- Lines B, C, D, E = 5 m × 15 = 75 BUs or **100 BUs** or 392/2 divided by 4 lines = 49 BUs
- Lines M, N = 10.6 × 15 = **159 BUs** or 100 BUs or 318/2 divided by 2 lines = 79.5 BUs

Single level (see Figure 26b):

- Lines A, B, C, D = 8.1 × 15 = **121.5 BUs** or 100 BUs or 414/2 divided by 4 lines = 51.8 BUs
- Lines M, N, O = 9.3 × 15 = **139.5 BUs** or 100 BUs or 414/2 divided by 3 lines = 69 BUs ➤



SHEET A BRANZ

Name of Applicant: ______ Site Address:
City/Town or District: ______
Street and Number ______
Or Lot and D.P. Number: ______

Box 1

LOCATION OF STOREY / BLOCK BEING ASSESSED

FOUNDATION SINGLE STOREY or UPPER STOREY [✓ LOWER STOREY] LOCATION IN BUILDING
Use one sheet for each and circle the appropriate location 2 story section

Box 2 Wind Bracing Demand (Table 5.5 , 5.6 or [✓ 5.7])

Wind zone (Table 5.1) L / [✓ M] / H / VH / EH
Building height to apex (H) 6·5 m
Roof height above eaves (H) 1·8 m

Note: Tables 5.5, 5.6, 5.7 relate to High wind zone.
In other wind zones, multiply the value by the appropriate factor.

(value from tables) (multiplication factor) (Bu/m)
W_{across} = 105 x { L 0.5 / [✓ M 0.7] / VH 1.3 / EH 1.6 } = 73·5
W_{along} = 110 x = 77
Transfer to Box 5

Box 3 Earthquake Bracing Demand (Table 5.8, [✓ 5.9], 5.10)

Earthquake zone (Figure 5.4) 1 / [✓ 2] / 3 / 4 Concrete slab Table 5.10
Weight of roof cladding [✓ Light] / Heavy Part storey in roof space Cl. 5.3.4.3
Roof pitch (degrees) 0-25 / [✓ 26-45] / 46-60 Part storey basement Cl. 5.3.4.4
Weight of upper (or single) storey cladding [✓ Light] / medium / heavy Chimney Cl. 5.3.4.5
Weight of lower storey cladding [✓ Light] / medium / heavy Wings / blocks Cl. 5.1.5
Weight of subfloor cladding Light / medium / heavy Deck projecting more than 2 m Cl. 7.4.2.2

(value) (multiplication factor below) (BU /m²)
BU/ m² (from tables 5.8, 5.9, 5.10) = 21 x ·5 = 10·5 Transfer to Box 5

NOTE: Tables 5.8, 5.9, 5.10 relate to soil type D/E in Earthquake zone 3, for multiplication factors for other soil types see below

Soil Class	Earthquake Zone			
	1	[✓ 2]	3	4
[✓ A & B Rock]	0.3	[✓ 0.5]	0.6	0.9
C Shallow	0.4	0.6	0.7	1.1
D/E Deep / Soft	0.5	0.8	1.0	1.5

Box 4 Building plan dimensions (Figure 5.3)

Roof or building length for wind across ridge L = 11·2 m Transfer to Box 5
Roof or building length for wind along ridge W = 5·6 m
Gross Floor Area GFA = 53 sq m

Box 5 Calculation of demand (Value) (Box 4 Dimension)

Wind Load Across (from box 2) = 73·5 x 11·2 = 823 BU
Wind Load Along (from box 2) = 77 x 5·6 = 431 BU
Earthquake Load (both directions) (from Box 3) = 10·5 x 53 = 557 BU

SHEET B BRANZ

LOCATION OF STOREY / BLOCK BEING ASSESSED
FOUNDATION SINGLE STOREY or UPPER STOREY [✓ LOWER STOREY] LOCATION IN BUILDING 2 story section
Use one sheet for each storey / block and circle the appropriate location

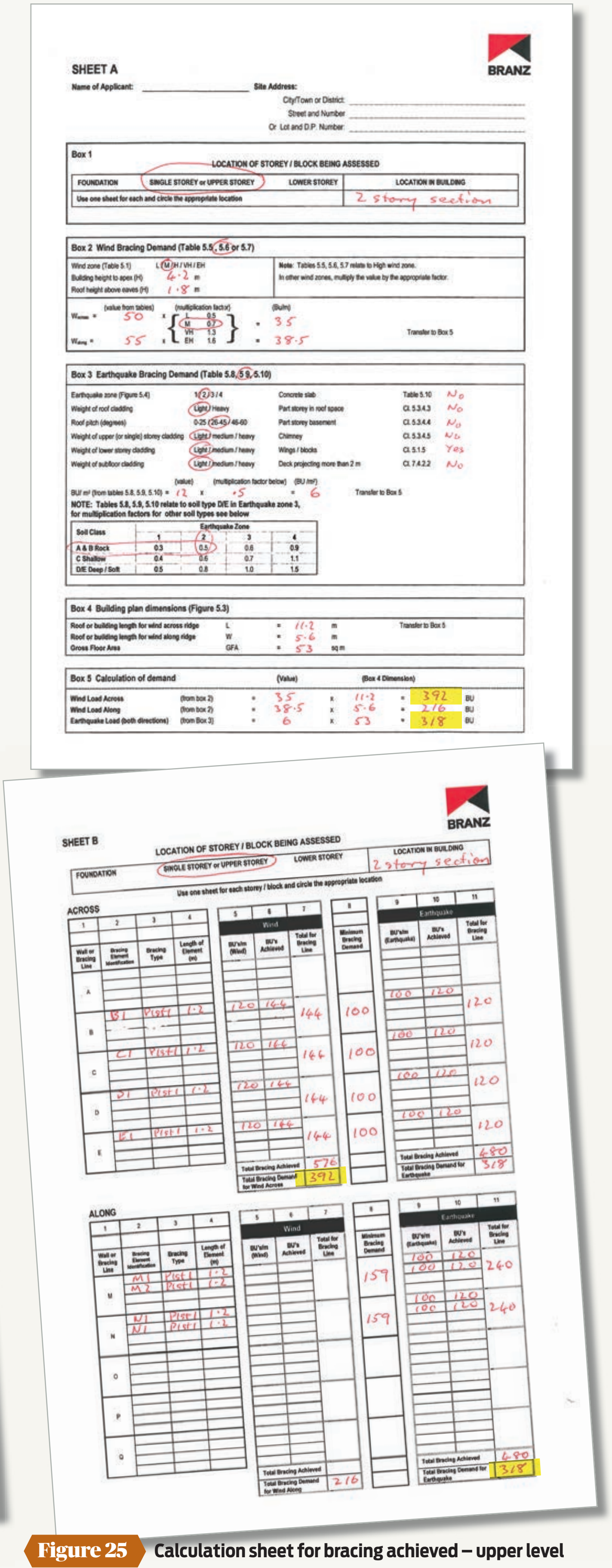
ACROSS

1	2	3	4	5	6	7	8	9	10	11
				Wind				Earthquake		
Wall or Bracing Line	Bracing Element Identification	Bracing Type	Length of Element (m)	BU's/m (Wind)	BU's Achieved	Total for Bracing Line	Minimum Bracing Demand	BU's/m (Earthquake)	BU's Achieved	Total for Bracing Line
A										
B	B2	Pst1	2·4	120	288	288	103	100	260	240
C	C2	Plst1	1·2	120	144	144	103	100	120	120
D	D2	Plst1	1·2	120	144	144	103	100	120	120
E	E2	Plst1	2·4	120	288	288	103	100	260	240
				Total Bracing Achieved		864		Total Bracing Achieved		720
				Total Bracing Demand for Wind Across		823		Total Bracing Demand for Earthquake		557

ALONG

1	2	3	4	5	6	7	8	9	10	11
				Wind				Earthquake		
Wall or Bracing Line	Bracing Element Identification	Bracing Type	Length of Element (m)	BU's/m (Wind)	BU's Achieved	Total for Bracing Line	Minimum Bracing Demand	BU's/m (Earthquake)	BU's Achieved	Total for Bracing Line
M	M3	Plst1	3·6				159	100	360	360
N	N3 N4	Plst1 Pst1	1·2 1·8				159	100 100	120 180	300
O										
P										
Q										
				Total Bracing Achieved				Total Bracing Achieved		660
				Total Bracing Demand for Wind Along		431		Total Bracing Demand for Earthquake		557

Figure 24 Calculation sheet bracing achieved – lower level of 2-storey.



SHEET A BRANZ

Name of Applicant: ______ Site Address:
City/Town or District: ______
Street and Number ______
Or Lot and D.P. Number: ______

Box 1

LOCATION OF STOREY / BLOCK BEING ASSESSED

FOUNDATION [✓ SINGLE STOREY or UPPER STOREY] LOWER STOREY LOCATION IN BUILDING
Use one sheet for each and circle the appropriate location 2 story section

Box 2 Wind Bracing Demand (Table 5.5, [✓ 5.6] or 5.7)

Wind zone (Table 5.1) L / [✓ M] / H / VH / EH
Building height to apex (H) 4·2 m
Roof height above eaves (H) 1·8 m

Note: Tables 5.5, 5.6, 5.7 relate to High wind zone.
In other wind zones, multiply the value by the appropriate factor.

(value from tables) (multiplication factor) (Bu/m)
W_{across} = 50 x { L 0.5 / [✓ M 0.7] / VH 1.3 / EH 1.6 } = 35
W_{along} = 55 x = 38·5
Transfer to Box 5

Box 3 Earthquake Bracing Demand (Table 5.8, [✓ 5.9], 5.10)

Earthquake zone (Figure 5.4) 1 / [✓ 2] / 3 / 4 Concrete slab Table 5.10 No
Weight of roof cladding [✓ Light] / Heavy Part storey in roof space Cl. 5.3.4.3 No
Roof pitch (degrees) 0-25 / [✓ 26-45] / 46-60 Part storey basement Cl. 5.3.4.4 No
Weight of upper (or single) storey cladding [✓ Light] / medium / heavy Chimney Cl. 5.3.4.5 No
Weight of lower storey cladding [✓ Light] / medium / heavy Wings / blocks Cl. 5.1.5 Yes
Weight of subfloor cladding [✓ Light] / medium / heavy Deck projecting more than 2 m Cl. 7.4.2.2 No

(value) (multiplication factor below) (BU /m²)
BU/ m² (from tables 5.8, 5.9, 5.10) = 12 x ·5 = 6 Transfer to Box 5

NOTE: Tables 5.8, 5.9, 5.10 relate to soil type D/E in Earthquake zone 3, for multiplication factors for other soil types see below

Soil Class	Earthquake Zone			
	1	[✓ 2]	3	4
[✓ A & B Rock]	0.3	[✓ 0.5]	0.6	0.9
C Shallow	0.4	0.6	0.7	1.1
D/E Deep / Soft	0.5	0.8	1.0	1.5

Box 4 Building plan dimensions (Figure 5.3)

Roof or building length for wind across ridge L = 11·2 m Transfer to Box 5
Roof or building length for wind along ridge W = 5·6 m
Gross Floor Area GFA = 53 sq m

Box 5 Calculation of demand (Value) (Box 4 Dimension)

Wind Load Across (from box 2) = 35 x 11·2 = 392 BU
Wind Load Along (from box 2) = 38·5 x 5·6 = 216 BU
Earthquake Load (both directions) (from Box 3) = 6 x 53 = 318 BU

SHEET B BRANZ

LOCATION OF STOREY / BLOCK BEING ASSESSED
FOUNDATION [✓ SINGLE STOREY or UPPER STOREY] LOWER STOREY LOCATION IN BUILDING 2 story section
Use one sheet for each storey / block and circle the appropriate location

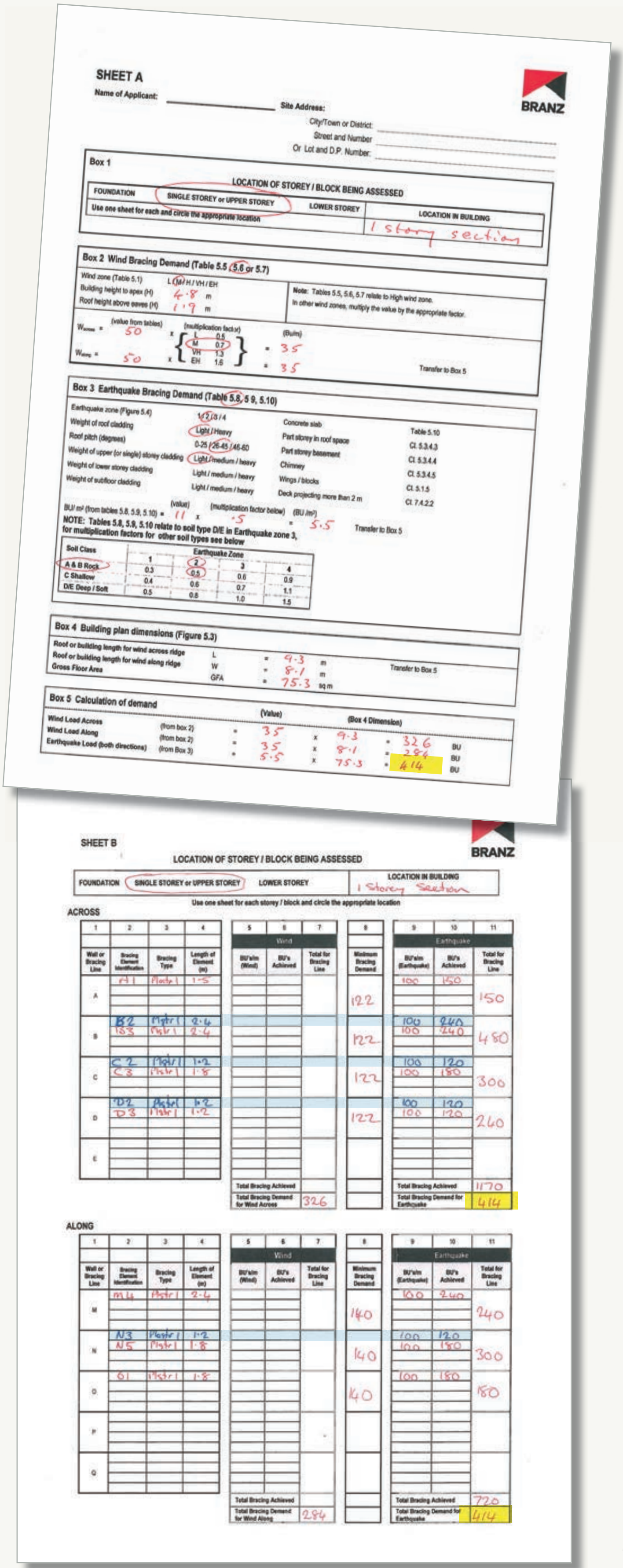
ACROSS

1	2	3	4	5	6	7	8	9	10	11
				Wind				Earthquake		
Wall or Bracing Line	Bracing Element Identification	Bracing Type	Length of Element (m)	BU's/m (Wind)	BU's Achieved	Total for Bracing Line	Minimum Bracing Demand	BU's/m (Earthquake)	BU's Achieved	Total for Bracing Line
A										
B	B1	Plst1	1·2	120	144	144	100	100	120	120
C	C1	Plst1	1·2	120	144	144	100	100	120	120
D	D1	Plst1	1·2	120	144	144	100	100	120	120
E	E1	Plst1	1·2	120	144	144	100	100	120	120
				Total Bracing Achieved		576		Total Bracing Achieved		480
				Total Bracing Demand for Wind Across		392		Total Bracing Demand for Earthquake		318

ALONG

1	2	3	4	5	6	7	8	9	10	11
				Wind				Earthquake		
Wall or Bracing Line	Bracing Element Identification	Bracing Type	Length of Element (m)	BU's/m (Wind)	BU's Achieved	Total for Bracing Line	Minimum Bracing Demand	BU's/m (Earthquake)	BU's Achieved	Total for Bracing Line
M	M1 M2	Plst1 Plst1	1·2 1·2				159	100 100	120 120	240
N	N1 N1	Plst1 Plst1	1·2 1·2				159	100 100	120 120	240
O										
P										
Q										
				Total Bracing Achieved				Total Bracing Achieved		480
				Total Bracing Demand for Wind Along		216		Total Bracing Demand for Earthquake		318

Figure 25 Calculation sheet for bracing achieved – upper level of 2-storey.



SHEET A

BRANZ

Name of Applicant: ____________ Site Address:
City/Town or District:
Street and Number
Or Lot and D.P. Number:

Box 1

LOCATION OF STOREY / BLOCK BEING ASSESSED

FOUNDATION [✓ SINGLE STOREY or UPPER STOREY] LOWER STOREY

Use one sheet for each and circle the appropriate location

LOCATION IN BUILDING: 1 story section

Box 2 Wind Bracing Demand (Table 5.5, [✓ 5.6] or 5.7)

Wind zone (Table 5.1) L / [✓ M] / H / VH / EH
Building height to apex (H) 4·8 m
Roof height above eaves (H) 1·9 m

Note: Tables 5.5, 5.6, 5.7 relate to High wind zone. In other wind zones, multiply the value by the appropriate factor.

W across = (value from tables) 50 x (multiplication factor) {L 0.5 / [✓ M 0.7] / VH 1.3 / EH 1.6} = (Bu/m) 35
W along = 50 x = 35
Transfer to Box 5

Box 3 Earthquake Bracing Demand (Table [✓ 5.8], 5 9, 5.10)

Earthquake zone (Figure 5.4)	1 / [✓ 2] / 3 / 4	Concrete slab	Table 5.10
Weight of roof cladding	[✓ Light] / Heavy	Part storey in roof space	Cl. 5.3.4.3
Roof pitch (degrees)	0-25 / [✓ 26-45] / 46-60	Part storey basement	Cl. 5.3.4.4
Weight of upper (or single) storey cladding	[✓ Light] / medium / heavy	Chimney	Cl. 5.3.4.5
Weight of lower storey cladding	Light / medium / heavy	Wings / blocks	Cl. 5.1.5
Weight of subfloor cladding	Light / medium / heavy	Deck projecting more than 2 m	Cl. 7.4.2.2

BU/ m² (from tables 5.8, 5.9, 5.10) = (value) 11 x (multiplication factor below) ·5 = (BU /m²) 5.5 Transfer to Box 5

NOTE: Tables 5.8, 5.9, 5.10 relate to soil type D/E in Earthquake zone 3, for multiplication factors for other soil types see below

Soil Class	Earthquake Zone			
	1	[✓ 2]	3	4
[✓ A & B Rock]	0.3	[✓ 0.5]	0.6	0.9
C Shallow	0.4	0.6	0.7	1.1
D/E Deep / Soft	0.5	0.8	1.0	1.5

Box 4 Building plan dimensions (Figure 5.3)

Roof or building length for wind across ridge L = 9·3 m
Roof or building length for wind along ridge W = 8·1 m
Gross Floor Area GFA = 75·3 sq m
Transfer to Box 5

Box 5 Calculation of demand

			(Value)		(Box 4 Dimension)		
Wind Load Across	(from box 2)	=	35	x	9·3	= 326	BU
Wind Load Along	(from box 2)	=	35	x	8·1	= 284	BU
Earthquake Load (both directions)	(from Box 3)	=	5·5	x	75·3	= 414	BU

SHEET B

BRANZ

LOCATION OF STOREY / BLOCK BEING ASSESSED

FOUNDATION [✓ SINGLE STOREY or UPPER STOREY] LOWER STOREY

LOCATION IN BUILDING: 1 Storey Section

Use one sheet for each storey / block and circle the appropriate location

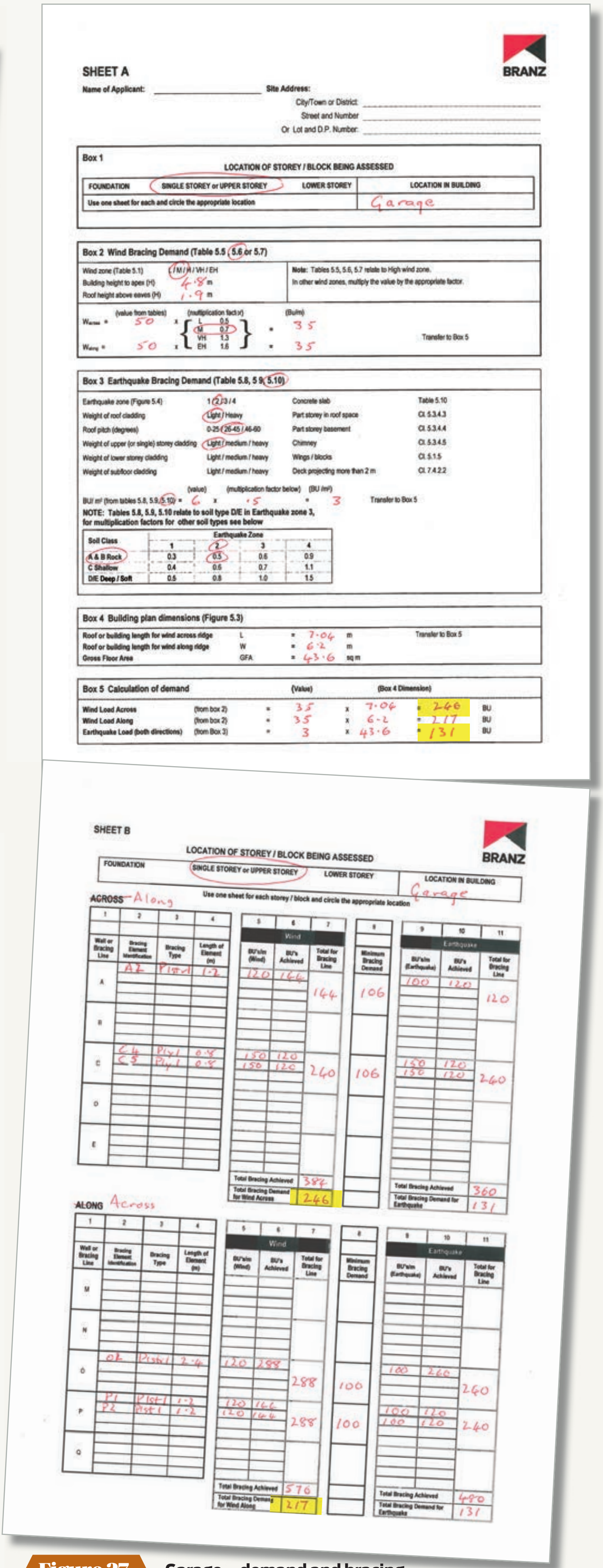
ACROSS

1	2	3	4	5	6	7	8	9	10	11
				Wind				Earthquake		
Wall or Bracing Line	Bracing Element Identification	Bracing Type	Length of Element (m)	BU's/m (Wind)	BU's Achieved	Total for Bracing Line	Minimum Bracing Demand	BU's/m (Earthquake)	BU's Achieved	Total for Bracing Line
A	A1	Plstr1	1·5				122	100	150	150
B	B2	Plstr1	2·4				122	100	240	480
	B3	Plstr1	2·4					100	240	
C	C2	Plstr1	1·2				122	100	120	300
	C3	Plstr1	1·8					100	180	
D	D2	Plstr1	1·2				122	100	120	240
	D3	Plstr1	1·2					100	120	
E										
				Total Bracing Achieved				Total Bracing Achieved		1170
				Total Bracing Demand for Wind Across		326		Total Bracing Demand for Earthquake		414

ALONG

1	2	3	4	5	6	7	8	9	10	11
				Wind				Earthquake		
Wall or Bracing Line	Bracing Element Identification	Bracing Type	Length of Element (m)	BU's/m (Wind)	BU's Achieved	Total for Bracing Line	Minimum Bracing Demand	BU's/m (Earthquake)	BU's Achieved	Total for Bracing Line
M	M4	Plstr1	2·4				140	100	240	240
N	N3	Plstr1	1·2				140	100	120	300
	N5	Plstr1	1·8					100	180	
O	O1	Plstr1	1·8				140	100	180	180
P										
Q										
				Total Bracing Achieved				Total Bracing Achieved		720
				Total Bracing Demand for Wind Along		284		Total Bracing Demand for Earthquake		414

Figure 26 Calculation sheet for demand – single level. Blue entries indicate overlap with 2-storey.



SHEET A

BRANZ

Name of Applicant: ____________ Site Address:
City/Town or District:
Street and Number
Or Lot and D.P. Number:

Box 1

LOCATION OF STOREY / BLOCK BEING ASSESSED

FOUNDATION [✓ SINGLE STOREY or UPPER STOREY] LOWER STOREY

Use one sheet for each and circle the appropriate location

LOCATION IN BUILDING: Garage

Box 2 Wind Bracing Demand (Table 5.5, [✓ 5.6] or 5.7)

Wind zone (Table 5.1) L / [✓ M] / H / VH / EH
Building height to apex (H) 4·8 m
Roof height above eaves (H) 1·9 m

Note: Tables 5.5, 5.6, 5.7 relate to High wind zone. In other wind zones, multiply the value by the appropriate factor.

W across = (value from tables) 50 x (multiplication factor) {L 0.5 / [✓ M 0.7] / VH 1.3 / EH 1.6} = (Bu/m) 35
W along = 50 x = 35
Transfer to Box 5

Box 3 Earthquake Bracing Demand (Table 5.8, 5 9, [✓ 5.10])

Earthquake zone (Figure 5.4)	1 / [✓ 2] / 3 / 4	Concrete slab	Table 5.10
Weight of roof cladding	[✓ Light] / Heavy	Part storey in roof space	Cl. 5.3.4.3
Roof pitch (degrees)	0-25 / [✓ 26-45] / 46-60	Part storey basement	Cl. 5.3.4.4
Weight of upper (or single) storey cladding	[✓ Light] / medium / heavy	Chimney	Cl. 5.3.4.5
Weight of lower storey cladding	Light / medium / heavy	Wings / blocks	Cl. 5.1.5
Weight of subfloor cladding	Light / medium / heavy	Deck projecting more than 2 m	Cl. 7.4.2.2

BU/ m² (from tables 5.8, 5.9, [✓ 5.10]) = (value) 6 x (multiplication factor below) ·5 = (BU /m²) 3 Transfer to Box 5

NOTE: Tables 5.8, 5.9, 5.10 relate to soil type D/E in Earthquake zone 3, for multiplication factors for other soil types see below

Soil Class	Earthquake Zone			
	1	[✓ 2]	3	4
[✓ A & B Rock]	0.3	[✓ 0.5]	0.6	0.9
C Shallow	0.4	0.6	0.7	1.1
D/E Deep / Soft	0.5	0.8	1.0	1.5

Box 4 Building plan dimensions (Figure 5.3)

Roof or building length for wind across ridge L = 7·04 m
Roof or building length for wind along ridge W = 6·2 m
Gross Floor Area GFA = 43·6 sq m
Transfer to Box 5

Box 5 Calculation of demand

			(Value)		(Box 4 Dimension)		
Wind Load Across	(from box 2)	=	35	x	7·04	= 246	BU
Wind Load Along	(from box 2)	=	35	x	6·2	= 217	BU
Earthquake Load (both directions)	(from Box 3)	=	3	x	43·6	= 131	BU

SHEET B

BRANZ

LOCATION OF STOREY / BLOCK BEING ASSESSED

FOUNDATION [✓ SINGLE STOREY or UPPER STOREY] LOWER STOREY

LOCATION IN BUILDING: Garage

Use one sheet for each storey / block and circle the appropriate location

ACROSS – Along

1	2	3	4	5	6	7	8	9	10	11
				Wind				Earthquake		
Wall or Bracing Line	Bracing Element Identification	Bracing Type	Length of Element (m)	BU's/m (Wind)	BU's Achieved	Total for Bracing Line	Minimum Bracing Demand	BU's/m (Earthquake)	BU's Achieved	Total for Bracing Line
A	A2	Plstr1	1·2	120	144	144	106	100	120	120
B										
C	C4	Ply1	0·8	150	120	240	106	150	120	240
	C5	Ply1	0·8	150	120			150	120	
D										
E										
				Total Bracing Achieved		384		Total Bracing Achieved		360
				Total Bracing Demand for Wind Across		246		Total Bracing Demand for Earthquake		131

ALONG Across

1	2	3	4	5	6	7	8	9	10	11
				Wind				Earthquake		
Wall or Bracing Line	Bracing Element Identification	Bracing Type	Length of Element (m)	BU's/m (Wind)	BU's Achieved	Total for Bracing Line	Minimum Bracing Demand	BU's/m (Earthquake)	BU's Achieved	Total for Bracing Line
M										
N										
O	O2	Plstr1	2·4	120	288	288	100	100	260	260
P	P1	Plstr1	1·2	120	144	288	100	100	120	240
	P2	Plstr1	1·2	120	144			100	120	
Q										
				Total Bracing Achieved		576		Total Bracing Achieved		480
				Total Bracing Demand for Wind Along		217		Total Bracing Demand for Earthquake		131

Figure 27 Garage – demand and bracing.

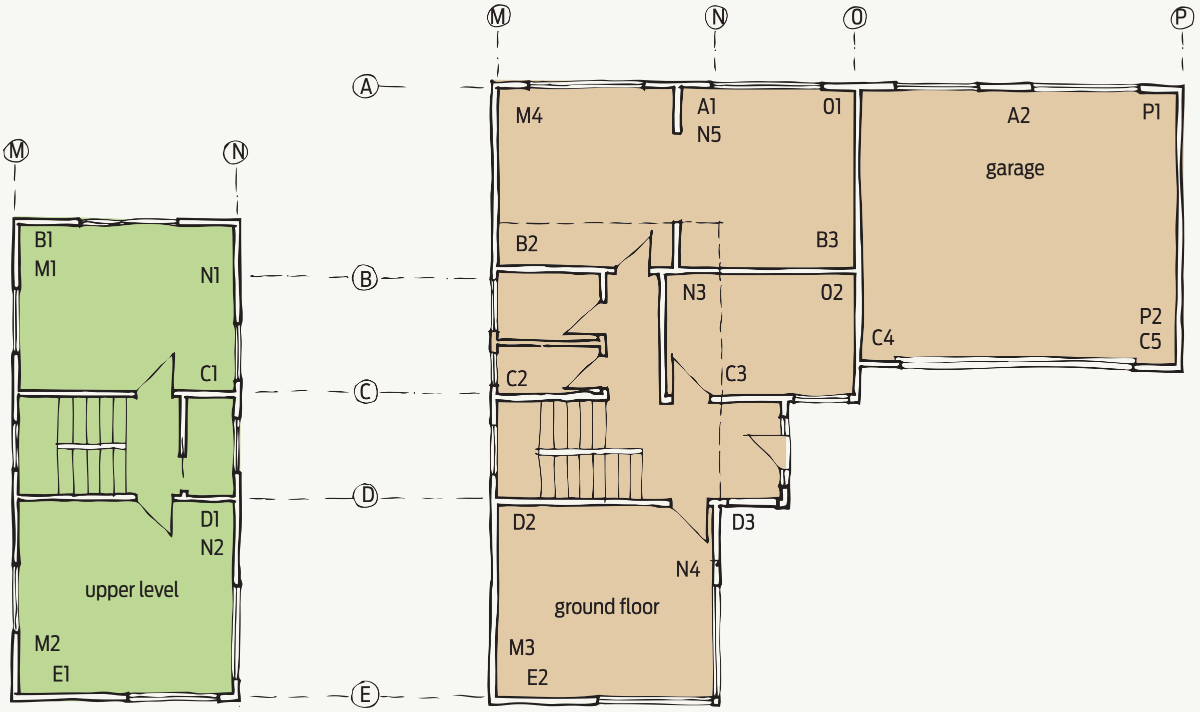


Figure 28 **Final bracing plan.**

Garage (see Fig 27b):

- Lines A, C = 7.040 × 15 = **105.6 BUs** or 100 BUs or 247/2 divided by 2 lines = 62 BUs
- Lines O, P = 6.2 × 15 = 93 BUs or **100 BUs** or 217/2 divided by 2 lines = 54.25 BUs

Transfer these values to the appropriate bracing sheets.

Choose bracing element

Bracing materials used are sheet products (ply, plasterboard, fibre cement and so on), concrete, concrete blocks or metal components. All bracing units are achieved using proprietary products that have had their bracing rating validated by the P21 test. The rating may vary for earthquake, wind and also for the length used. For example, a sheet material that is rated as achieving 120 BUs for wind, may have a lesser rating when used for earthquake or the sheet width is less than the manufacturer's minimum width.

BUs ratings are all derived from testing elements at 2.4 m high. Bracing elements of other heights will require the BUs achieved to be calculated for the height used using clause 8.3.1.4 of NZS 3604:2011.

In this example

For this exercise, a generic plasterboard has been used with a rating of 120 BUs for wind and 100 BUs for earthquake. This has been given the designation 'Plstr 1' in the worksheets.

For the bracing sheets either side of the garage door in bracing line C, a generic ply has been chosen, designated in the worksheet as 'Ply 1'. This has a rating of 150 BU/m for wind and earthquake. Proprietary sheet linings tested by manufacturers usually require some form of hold-downs – always follow the manufacturer's details. Never mix details from different systems.

Note **Having trouble reading Figures 24–27? You can download these with this article from www.buildmagazine.co.nz, then The Right Stuff.**

9

Walls at angles to bracing lines

BRACING CALCULATIONS ARE A LITTLE DIFFERENT FOR WALLS THAT RUN AT ANGLES TO THE BRACING LINES, BUT IT'S STILL IMPORTANT TO KNOW WHAT THEY CONTRIBUTE TO THE BRACING OF THE BUILDING.

BRACING CALCULATIONS using NZS 3604:2011 can be done for walls that are under 6 m long that run at an angle to the bracing lines. If the wall is over 6 m, however, the section of the building needs to be calculated as a separate building.

Data for this example

The building for this example (see Figure 29) is single storey with a roof pitch below 25 degrees, so wall lengths have been used to calculate demand (see NZS 3604:2011 clause 5.2.6).

Wind zone: High, so use default values in NZS 3604:2011 Table 5.6.

H = 3 m

h = 1 m

Always use the higher bracing demand out of wind or earthquake. Calculations for this example determined wind is the higher bracing demand, so Table 5.6 is used.

Bracing demand across the ridge

Total bracing units required in lines at right angles to the ridge of the main body of the house

= length of building (line A–B1) × 30 BU/m (from Table 5.6)

= 16 m × 30 BU/m = 480 BUs.

Bracing line at 90 degrees

In line **AE**, the full value of a proprietary bracing element can be used. For example, if Plaster 1 was rated at 100 BU/m and was 1.2 m long, it would achieve 120 BUs in the across direction.

Bracing line at angle

But in wall **DH**, the same bracing element type and length would be derated, as the line runs at 30 degrees to the brace lines.

Multiply the bracing element in the DH wall by 0.87 (see clause 5.4.4). This means a 1.2 m bracing element (Plaster 1 rated at 100 BU/m) would be calculated at:

100 BUs × 0.87 × 1.2 = 104.4 BUs.

Bracing demand along the ridge

Total bracing units required in lines running parallel to the ridge of the main body of the house

= width of building (line A–H1) × 35 BU/m (from Table 5.6)

= 9.5 m × 35 BU/m = 332.5 BUs.

Bracing line at 90 degrees

In Lines **AB** and **EF,** the full value of the bracing element can be claimed.

Bracing line at angle

Wall **GH** runs at 30 degrees to the brace lines, so multiply the bracing element in that wall by 0.87 (see clause 5.4.4). This means a 1.2 m bracing element (Plaster 1 rated at 100 BU/m) would be calculated at:

100 BUs × 0.87 × 1.2 = 104.4 BUs.

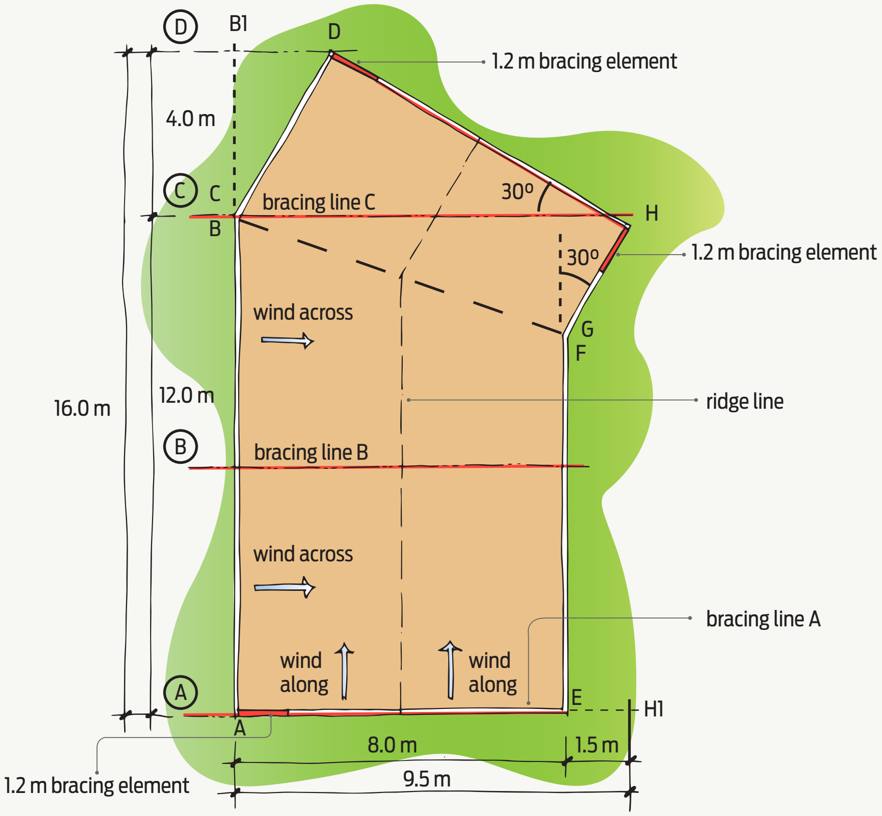


Figure 29 Bracing on single-storey example building.

10 Roof bracing

NEXT, WE MOVE UP, CALCULATING ROOF BRACING REQUIREMENTS.

USING THE SAME HOUSE as in the previous sections on subfloor bracing (see pages 14–17) and wall bracing (see pages 21–25), we use NZS 3604:2011 *Timber-framed buildings* Section 10.3 to work out the roof space and roof plane bracing required.

The roof

The house has a gable roof with 300 mm overhangs at the soffit and verge on the 2-storey section and a hip roof on the single-storey section (see Figure 30). The roof is a light roof.

Bracing sometimes not required

For truss and framed roofs, roof space bracing and roof plane bracing are not required where there is sarking that meets NZS 3604:2011 clause 10.4.4 requirements or where there is a structural ceiling diaphragm complying with clause 13.5 directly attached to the rafters.

Small roof planes less than 6 m², such as dormers or porches, also do not require bracing.

Minimum bracing requirements

Table 10.16 sets out the minimum roof bracing requirements for roof plan areas, including the overhangs. Use this for gable roofs, hip roofs and combinations of these.

For a heavy roof

For each 25 m² of roof plan area or part thereof, one roof plane diagonal brace or one roof space diagonal brace is required.

For a light roof

For each 50 m² of roof plan area or part thereof, one roof plane diagonal brace or one roof space diagonal brace is required.

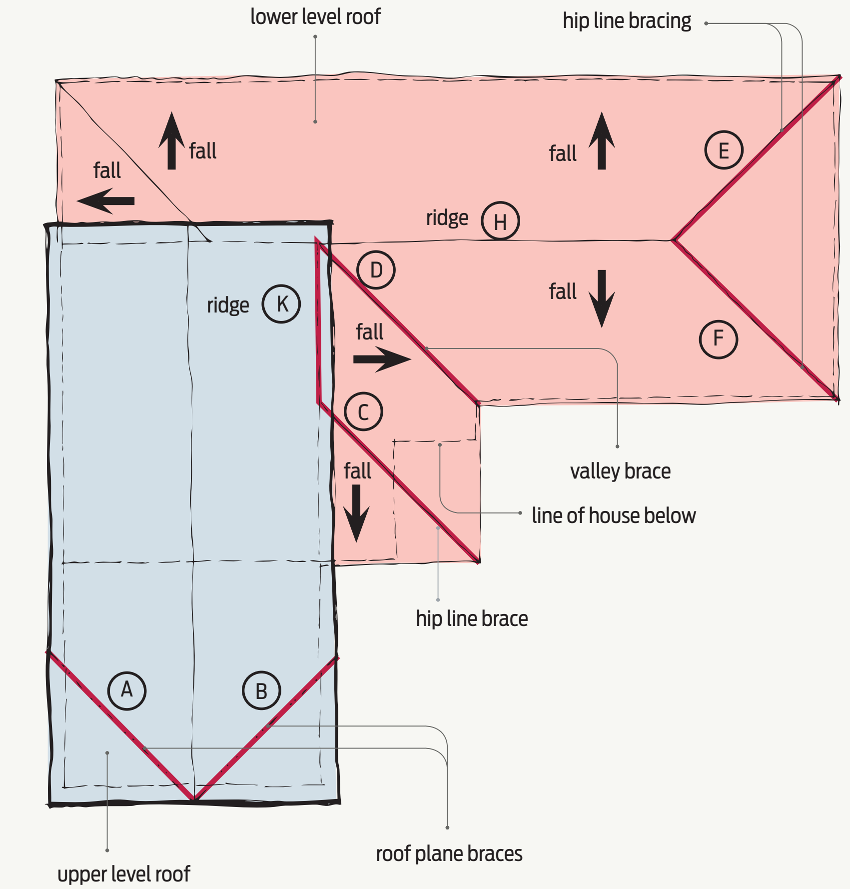


Figure 30 **Roof bracing.**

Monopitched roofs

Unless the walls have full-height bracing and a ceiling that is attached directly to the rafters, a monopitched roof must be considered as a pitched roof. Consider the highest support to be the ridge line and use heavy or light roof requirements as appropriate.

Low-slope roof

No specific provisions are required for low-slope roofs less than 5º.

Girder trusses used for low-slope roofs are likely to require some form of bracing from the top plate to the top cord – check with the fabricator. ➤

Roof plane and space braces

Combinations of roof plane or roof space braces are permitted provided the number of total braces is achieved.

Roof plane braces

There are several options of roof plane braces (see Figure 31):

- Hips and/or valleys. There must be a minimum of two (there is an error in NZS 3604:2011, which requires three) that run from top plate to ridge. Additional valleys or hips that also run from top plate to ridge are counted as one additional brace. Valley fixing details are in NZS 3604:2011 Table 10.1, type E fixings.
- For hip fixing requirements, see Table 10.1 for fixings at the top to the ridge and at the bottom of the hip to top plate type E or F fixings.
- A single length of timber (90 x 19 mm) fixed to the underside of rafters or top cords of trusses, running at 45^0 from ridge to dwang between ceiling joists near and parallel to the top plate (see Figure 10.22). Fix as required in clause 10.4.2.3 and Table 10.18.
- A diagonally opposing pair of steel strap braces with a minimum capacity of 4 kN in tension, fixed to each top cord or rafter and at the ends as required in Table 10.18.

Braces are required to intersect each end of the ridge line. Additional braces (where required) are to be distributed evenly along the ridge line.

Roof space braces

See Figure 32 (or NZS 3604:2011 Figure 10.23) for roof space brace set-up and anchoring.

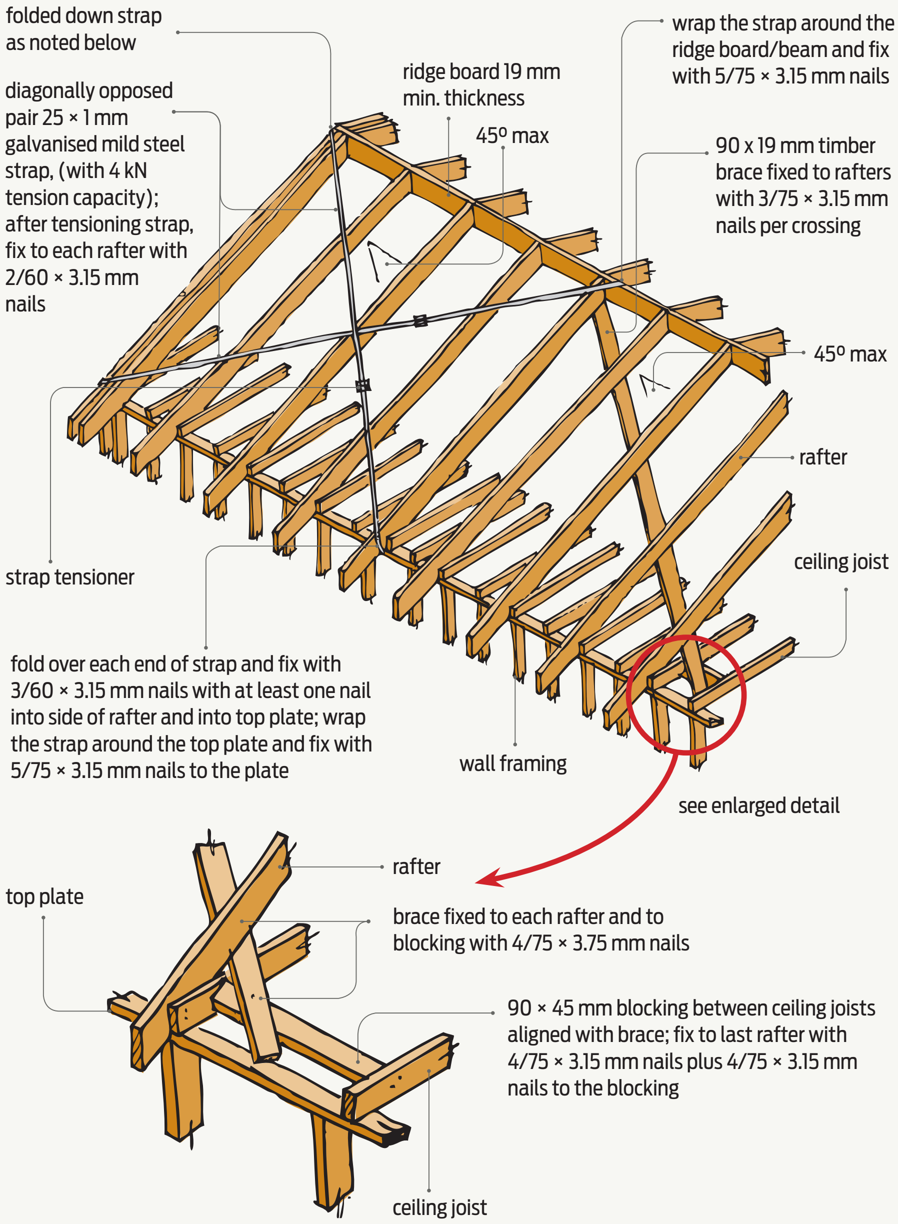
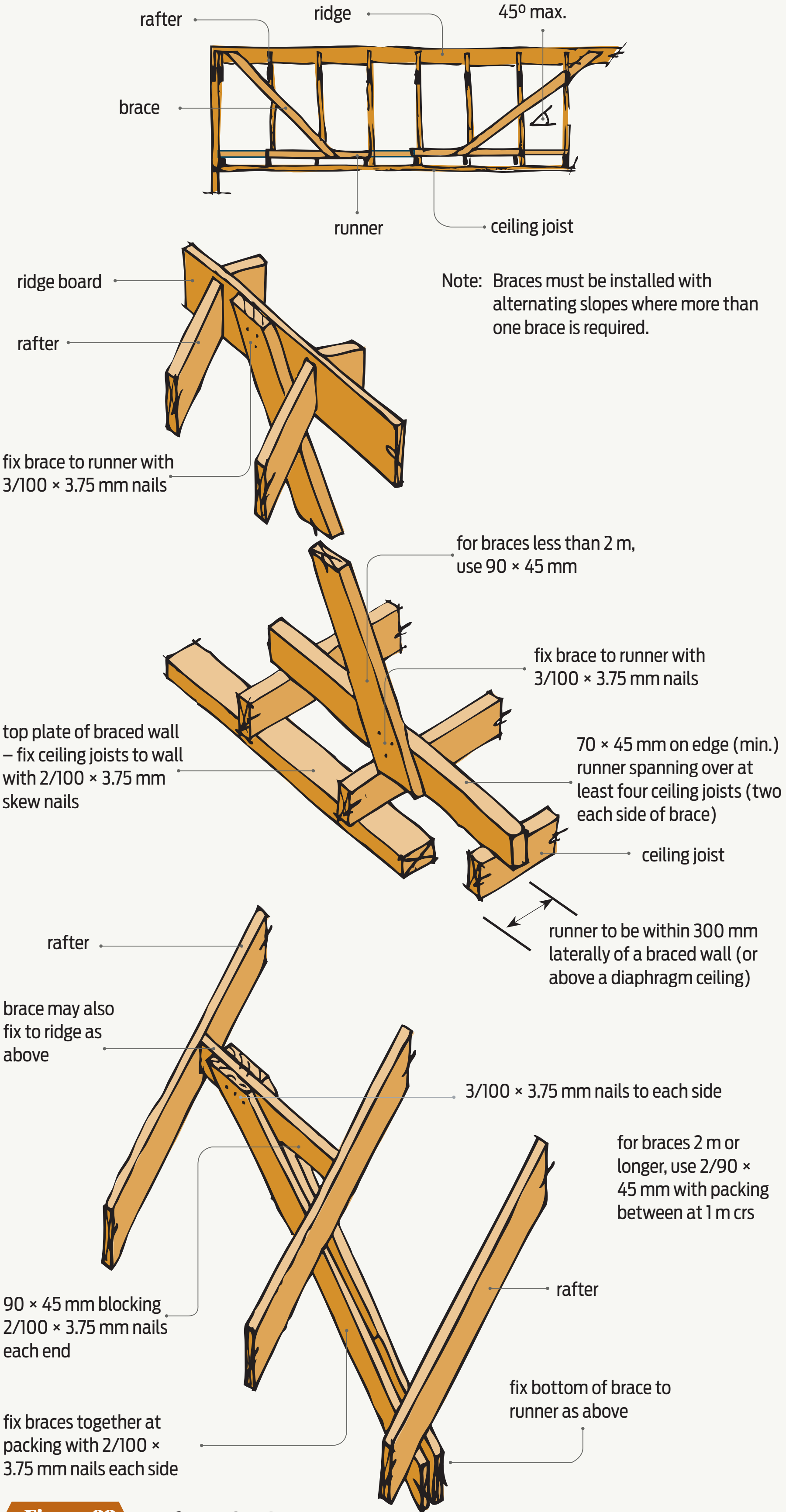


Figure 31 Roof plane bracing alternatives.



Note: Braces must be installed with alternating slopes where more than one brace is required.

Figure 32 **Roof space bracing.**

Note: Max. brace slope to horizontal is 45º.

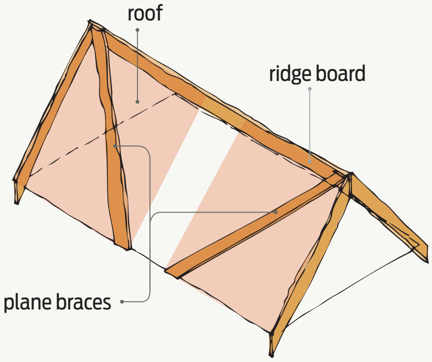


Figure 33 **Roof plane bracing.**

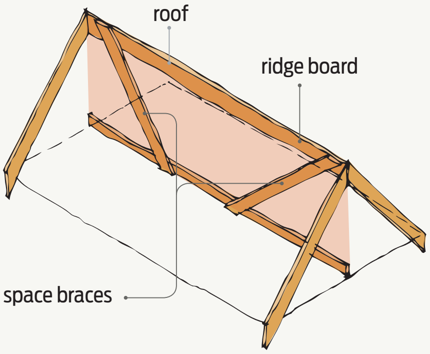


Figure 34 **Roof space bracing.**

Back to the example

The upper storey roof plan area is 5.6 × 11.2 = 62.72 m².

One roof brace is required per 50 m² with a minimum of two per ridge line.

Upper storey solution – a minimum of two braces are required for the upper storey roof (see Figure 30). Braces are marked in red (A and B).

The lower roof plan area (no soffit) = (7.040 × 6.2) + (8.1 × 3.1) + (6.2 × 3.1) = 68.7 m².

One roof brace is required per 50 m² with a minimum of two per ridge line.

Lower roof solution – minimum of two braces are required for the lower storey roof but also a minimum of two per ridge line (see Figure 30). The hips and valleys already provided will suffice without any additional braces. In Figure 30, the braces are marked in red (C and D for ridge line K and E and F for ridge line H). ◀

11 Bracing ratings

RECENT BRANZ TESTING HAS QUANTIFIED THE BRACING RATINGS OF SOME COMMON OLDER GENERIC BRACING SYSTEMS. THESE RATINGS WILL BE USEFUL DURING REPAIRS OR RENOVATIONS OF OLDER BUILDINGS.

FOR NEW HOUSES, manufacturers generally provide wall bracing ratings for their proprietary systems based on results of the BRANZ P21 test method. Designers then ensure that the demand wind or earthquake loads at each level and in each direction are less than the sum of the resistances of the bracing elements.

For renovations or repairs of older buildings, however, the bracing strength of existing construction is often not known. What should be used in the bracing calculations required by building consent authorities?

BRANZ tested older systems

In a Building Research Levy-funded project, BRANZ tested a range of older bracing systems (see Table 3) to provide wall bracing ratings.

In most cases, 2.42 m high timber frames were constructed using 90 × 45 mm kiln-dried MSG 8 radiata pine timber with plates nailed to studs with two 90 × 3.15 mm power-driven glue-shank nails. Although these differ from the original timber and nails, the difference in performance is considered small.

Figure 35 **The Brace 3 specimen – double diagonal braces cut between studs.**

The bottom plates of the walls were fixed to the foundation beam using pairs of 100 × 4 mm hand-driven galvanised nails at 600 mm centres starting 150 mm from the outside stud.

Nogs, where used, were at 800 mm centres except for system Brace 4, where they were at 600 mm centres.

Studs were at 600 mm centres (although in practice they were often at 450 mm centres) except for Lath 1 where they were at 400 mm centres.

Each specimen was subjected to three cycles of in-plane displacement at top plate level to each of +/-8.5 mm, +/-15 mm, +/-22 mm, +/-29 mm, +/-36 mm, +/-43 mm and +/-65 mm.

...and established bracing ratings

The proposed bracing ratings for existing and renovated walls based on the BRANZ testing are in Table 1.

Budgetary constraints meant that it was not possible to test three replicates of each system but the bracing contributions are generally quite low, meaning that any variations in actual strength compared to the tested strength would not influence the overall resistance of the structure markedly.

For more BRANZ Study Report SR305 *Bracing ratings for non-proprietary bracing walls* can be downloaded from www.branz.co.nz.

Table 3

SUMMARY OF PROPOSED BRACING RATINGS

NAME	BRACING SYSTEM	STRENGTHENING	FIXING	NOGS	FIXING PATTERN	WALL LENGTH (M)	RECOMMENDED BRACING RATING (BUS)		
							WIND	EARTHQUAKE	
LATH 1	45 × 6 mm lath and plaster wall with no horse hair	None	Type E	No	Type 6	2.4	36	32	per metre
BRACE 1	150 × 25 mm let in brace at 45°	None	Type C	No	Type 2	2.4	48	43	per brace
		Type 1					51	45	per brace
BRACE 2	90 × 45 mm single brace cut between studs	Test set-up did not completely replicate installed conditions so no definitive bracing rating provided.							
BRACE 3	90 × 45 mm double brace cut between studs	None	Type D	No	Type 3	2.4	44	39	per brace pair
		Type 1					70	62	per brace pair
BRACE 4	Dogleg brace	None	Type D	@ 600 mm	Type 3	0.6	16	14	per brace
		Type 1					19	17	per brace
BOARD 1	200 × 10 mm horizontal board	None	Type F	No	Type 7	1.2	23	21	per metre
BOARD 2	140 × 20 mm bevel-back weatherboard	None	Type G	Yes	Type 5	2.4	7	6	per metre
SHEET 1	Standard plasterboard one side only	None	Type A	Yes	Type 1	1.2	20	18	per metre
SHEET 2	Standard plasterboard two sides	None	Type A	Yes	Type 1	1.2	47	41	per metre
SHEET 3	3.2 mm tempered hardboard one side only	None	Type H	Yes	Type 4	1.2	29	26	per metre
		Type 2	Type A	Yes	Type 4	1.2	57	50	per metre
		Type 3	Type A	Yes	Type 4	1.2	99	88	per metre
SHEET 4	Horizontal corrugated steel	None	Type I	Yes	Type 8	2.4	38	34	per metre
SHEET 5	Vertical corrugated steel	None	Type I	Yes	Type 9	2.4	31	28	per metre

Legend

Fixing

A 30 × 2.5 mm galvanised flathead nails
C 75 × 3.15 mm galvanised flathead nails
D 75 × 3.15 mm bright jolthead nails
E 25 × 2.5 mm galvanised flathead clouts
F 40 × 2.8 mm galvanised flathead nails
G 60 × 3.15 mm bright jolthead nails
H 30 × 1.6 mm electroplated panel pins
I Leadhead nails with 60 × 3.5 mm bright shanks

Fixing pattern

1 A nail at each corner and then at 300 mm centres to all studs and plates
2 Two nails brace to each stud and three nails brace to each plate
3 Two nails each end of braces
4 A nail at each corner and then at 200 mm centres to all studs and plates
5 Weatherboards fixed to studs with a single nail at 40 mm from the bottom of each weatherboard
6 Laths fixed with a single nail
7 Two nails at each board/stud intersection
8 Nails used at every second ridge to studs, except third ridge one side of lap
9 Nails used at every second ridge to nogs and plates, except third ridge one side of lap

Strengthening

1 Strap at brace top between top plate and end stud
2 Replace panel pins with 30 × 2.5 mm nails
3 Add 100% rocking restraint and 30 × 2.5 mm nails

CarterHoltHarvey
Woodproducts New Zealand

ecoply®
Proven. Durable. Strong

IT'S A MATTER OF TRUST

ECOPLY® STRUCTURAL Square EDGE

ECOPLY® STRUCTURAL FLOORING

ECOPLY® STRUCTURAL ROOFING

ECOPLY® STRUCTURAL Grooved LINING

ECOPLY® STRUCTURAL BARRIER

ECOPLY® STRUCTURAL Cut To SIZE

ECOPLY®: THE PROVEN PERFORMER

When it comes to bracing not all structural plywood is created equal. It is now more important than ever to specify product compliant with the NZ Building Code.

Not only is our Ecoply® range of structural plywood independently tested to meet New Zealand bracing standards, we offer in-depth online, technical support and expertise to back up our products.

The EP bracing series has been specifically tested to conform to NZS 3604: 2011. Ecoply EP bracing series simplifies the design and construction of bracing elements using plywood, by itself or in conjunction with GIB® plasterboard.

With this kind of assurance why would you build with anything else?

Ecoply® - Specify with Confidence.

FSC™ www.fsc.org

JAS-ANZ®

PRODUCT CERTIFIED paa ENGINEERED WOOD

ewpaa

NEW ZEALAND MANUFACTURED

0800 326 759
www.chhwoodproducts.co.nz