CFG Concrete Ltd

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NEW ZEALAND ADDENDUM

SINGLE STOREY HEBEL BLOCK CONSTRUCTION

I. New Zealand Addendum

CONTENTS

Section 1: GENERAL INTRODUCTION

1.1 Purpose of the NZ Addendum

1.0 This publication is to be used in conjunction with the CSR Hebel Technical Manual to aid New Zealand Engineers, Architects, Designers and Builders when designing and erecting single storey structures, that incorporate CSR Hebel autoclaved aerated concrete (AAC) block products.

The CSR Hebel Technical Manual contains information about CSR Hebel products and product data, appropriate design methods, design tables, and installation and handling methods. Although most of the information in the CSR Hebel Technical Manual is universal, some sections are based on the Building Code of Australia and Australian Codes and requirements which are different to those that apply in New Zealand, particularly in regard to design for earthquakes.

This addendum provides New Zealand specific information where appropriate. In particular, the information and design concepts on how to design with CSR Hebel products and the accompanying design tables have been revised where considered appropriate to comply with New Zealand Code requirements. Where information does not require modification, designers are referred to the current CSR Hebel Technical Manual.

1.2 How to use the Addendum

The Addendum is to be used in conjunction with the CSR Hebel Technical Manual. The following indicates the correlation between the two documents:

NZ Addendum		CSR Hebel Technical Manual
Section 2: Designing with CSR Hebel for New Zealand Conditions	***replaces (where appropriate)***	Part 5: Fire Design; & Part 6: CSR Hebel Block Wall Design & Construction
Section 3: Construction Details	***is additional to (where appropriate)***	Part 6: CSR Hebel Block Wall Design & Construction
Section 4: Design Examples – Single Storey Construction	***is new***	

It should also be noted that in the CSR Hebel Technical Manual:

- Appendix D (Construction Notes), shall be amended to satisfy relevant New Zealand requirements.
- Appendix E (Guide Specifications – Hebel Blocks), the Australian Standards listed in Sections 4 and 5, need to be replaced with appropriate New Zealand standards.
- Appendix E (Guide Specifications – Hebel PowerPanel), the Australian Standards listed in Section 4 need to be replaced with appropriate New Zealand Standards.

1.3 Limitations of the NZ Addendum

2.0 The design methods, tables and examples are limited to buildings subjected to residential type loadings and is applicable to single-storey height construction, constructed in accordance with NZS 4230:1990 *Code of Practice for the Design of Masonry Structures.*

The block product specifications, range and performance characteristics, and design tables in this CSR Hebel Technical Manual, New Zealand Addendum are applicable only to CSR Hebel materials and products, and are those current as of 4th March, 2004.

1.4 Disclaimer

The information presented herein is supplied in good faith and to the best of our knowledge was accurate at the time of preparation. The provision of this information should not be construed as a recommendation to use any of our products in violation of any patent rights or in breach of any statute or regulation. Users are advised to make their own determination as to the suitability of this information in relation to their particular purpose or specific circumstances. Since the information contained in this document may be applied under conditions beyond our control, no responsibility can be accepted by CSR Hebel or its staff for any loss or damage caused by any person acting or refraining from action as a result of misuse of this information.

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Section 2: DESIGNING WITH CSR HEBEL FOR NEW ZEALAND CONDITIONS

2.1 Introduction

The New Zealand Addendum (NZ Addendum) was produced to address the differences between Australian and New Zealand design practices and methodologies. Where appropriate, this Addendum presents the sections that replace corresponding sections of Parts 5 & Part 6 of the CSR Hebel Technical Manual. The NZ Addendum is to be used in conjunction with NZS 4229:1999: *Concrete Masonry Buildings Not Requiring Specific Engineering Design,* as a guide to suitably qualified and experienced structural design engineers.

These notes generally follow the design requirements and procedures of NZS 4229, but there are some parts of the design process which are additional to NZS 4229 and which require specific engineering design, such as the checking of out-of-plane lateral load capacities of vertically spanning walls under wind loading.

Currently New Zealand standards do not specifically cover Autoclaved Aerated Concrete (AAC) products, therefore some of the tables have been derived from the requirements of Australian Standard AS 3700-2001:*Masonry Structures,* which does specifically include AAC block design.

2.2 Design Flow Charts

Flow charts to aid the design process have been prepared for single-storey construction structures.

They follow the general procedures of NZS 4229:1999 *Concrete Masonry Buildings Not Requiring Specific Engineering Design*, and indicate where Tables, Charts, etc. have been modified for, or are specific to AAC, replacing the relevant NZS 4229 tables and information.

A flow chart for single-storey construction is presented in Section 5.

2.3 Important Considerations When Designing With CSR Hebel Blocks

a) Foundations

Designed using NZS4229 where appropriate, or for FULL MASONRY or ARTICULATED FULL MASONRY in accordance with Australian Standard AS2870, 1996 *Residential Slabs and Footings*, when ground conditions do not fall within the NZS classification of “good ground”.

b) Movement Joints

Movement joints (M.J.) are required to minimise and control cracking in a block wall by breaking the wall into separate masonry panels at points of weakness. These movement joints can be described as articulation joints (A.J.) and control joints (C.J.).

c) Coatings & Linings

Only coating manufacturer recommended coating systems should be used on CSR Hebel AAC block walls. For New Zealand conditions, CSR Hebel does not recommend the use of oxide-tinted renders.

Ensure coatings are suitable for use on CSR Hebel AAC, i.e., coating manufacturer’s specification. Refer to the CSR Hebel Technical Manual Part 9 for further information.

CSR Hebel recommends lining 100mm and 125mm thick internal block walls with plasterboard sheeting.

d) Bond Breaker Layer / Damp Proof course

2.1 A necessary part of a CSR Hebel AAC block wall is the bond breaker layer, which is installed at the base of the wall between the concrete foundation and the wall. This layer accommodates the different shrinkage rates and differential movement/ displacement of the CSR Hebel AAC blockwork and concrete by allowing localised slip to occur, which helps relieve any build up of stress. Typically, a damp-proof course (DPC) material is used with CSR Hebel AAC block walls to provide a slip plane, as well as prevent rising damp in the wall. Refer to the CSR Hebel Technical Manual Part 6 for further details.

2.2 A damp proof course (DPC) membrane is also recommended for use with CSR Hebel walls, to prevent damp rising in masonry.

e) Workmanship

Refer to CSR Hebel Technical Manual Part 6 for further details.

f) Lateral Stability of CSR Hebel Block Walls During Construction

Free-standing block walls which have no returns, anchorage to a base, or a lateral support provided by a roof or floor diaphragm, should not be used in any circumstances.

If during construction a wall is temporarily free standing, it should be braced until such time as the cross walls, vertical reinforcement and other stabilising elements have been placed to ensure the stability of the wall.

2.4 Block Wall Design

All walls, whether or not forming part of a bracing system to resist lateral loads, shall have vertical reinforcement at specified centres along their length. The structural engineer shall determine the amount of reinforcement to be installed and reinforcement spacing. The bracing charts in this Addendum are based on 1000 mm centres.

Design for CSR Hebel AAC block walls is not specifically covered under NZS 4230 - Part 1: 1990 at this stage. The design information, including charts and tables, presented in the following section is based on the relevant section of AS3700-2001: *Masonry Structures,* where AAC blockwork is specifically included. All walls shall satisfy the design requirements of Clause 10.3.2.1 of NZS4230.

Structural Walls

Generally, the minimum recommended wall thickness, is:

- 200 mm for external walls, and (other thicknesses are available: 225, 250 & 300mm)
- 150 mm for internal walls.

CSR Hebel suggests considering a wall as having top and bottom lateral restraints only (one-way vertical span) and designing the appropriate wall thickness, so that retrofitting or changing the location of the movement joints will not be detrimental to the lateral load capacity of the wall. In determining the appropriate wall thickness, the designer shall consider a range of factors relating to relevant codes and project specific considerations, these factors may include:

- Movement joint location.
- Bracing considerations.
- Vertical (compression) loading.
- Out-of-plane wind/earthquake (lateral) loading.
- Required fire rating level (FRL).

The particular project loading configurations could result in walls that exceed the above minimum requirements.

Non-Structural Walls

Non-structural internal walls may be as thin as 100mm thick. However it is recommended that these walls be lined both sides with plasterboard sheeting.

2.5 Movement Joints (M.J.)

NOTE: This section replaces Part 6.4 of the CSR Hebel Technical Manual

During the life cycle of a building, the building and the materials that it is constructed from will move. These movements are due to many factors working together or individually, such as foundation movement (shrinkage and swelling), thermal expansion and contraction, differential movements between materials, climate and soil condition. This movement, unless relieved or accommodated for, will induce stress in the materials, which may be relieved in the form of cracking. To accommodate these movements and relieve any induced stresses, which could potentially crack the wall, movement joints (vertical gaps) shall be installed. There are two categories of joints:

- ***Articulation joints (A.J.)*** are provided to relieve induced stresses due to foundation movement. The joints make the walls more flexible by breaking the wall into a series of small panels, which is especially required on reactive ground conditions (clay, peat). Differential movement between the AAC blockwork and adjacent structural elements need to be accommodated with articulation joints, such as blockwork infill between the structural frame.

- ***Control joints (C.J.)***, (one type is an expansion joint), are provided to relieve the induced stresses resulting from thermal expansion or contraction of the AAC, or differential movement between the AAC and another material or structure, such as abutting walls or columns of concrete or brickwork. Control joints can delineate coating shrinkage breaks.

A joint may perform the function of either an articulation joint, or control joint, or both.

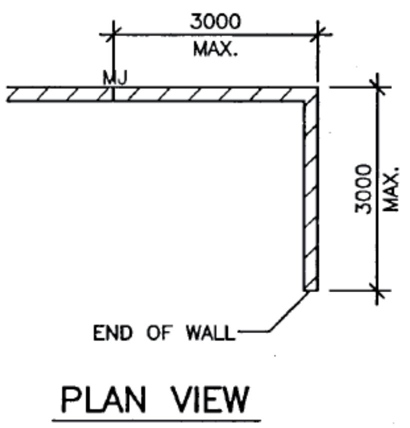
Movement Joints should be designed as per the detail on page I – 27.

IMPORTANT: There are restrictions provided to the maximum length of wall:

- 6 metres maximum for continuous runs of walls.
- When measuring the 6 metre run of wall, the measurement continues around corners till the end of the wall or a movement joint.

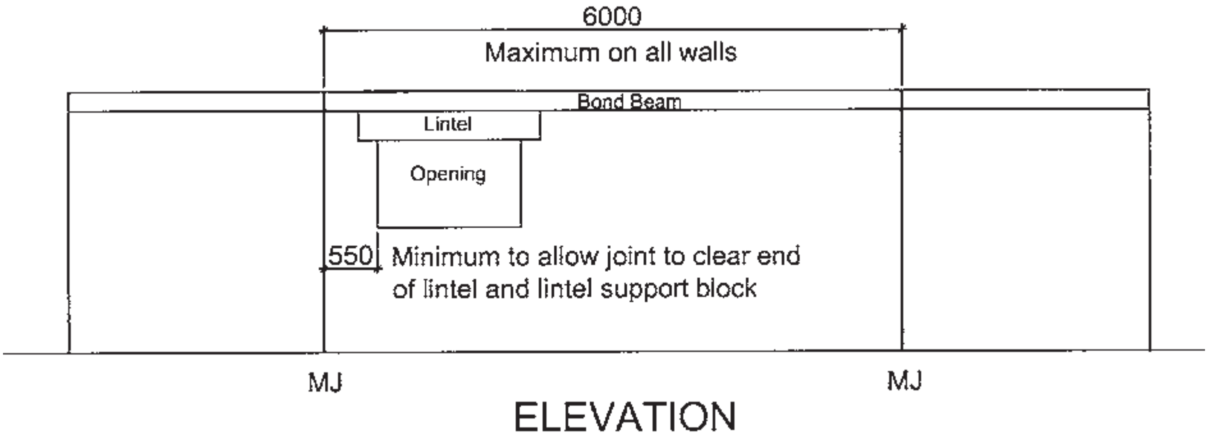
The project architect and engineer shall be responsible for determining the optimum location of movement joints, as their location is dependent on a variety of factors including most importantly the structural stability and bracing requirements of the building. Areas to be considered, but not limited to, include:

- **Long or short walls tied to each end with substantial, rigid return walls.**

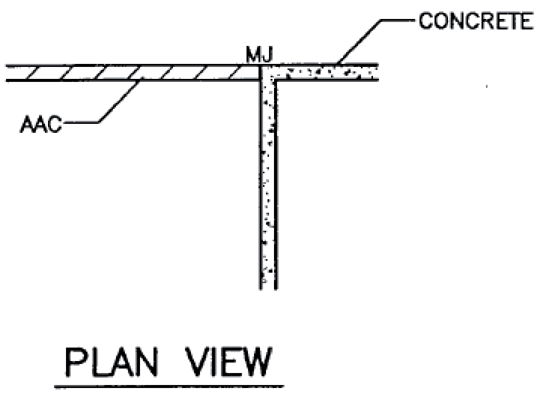


- **Adjacent to openings.**

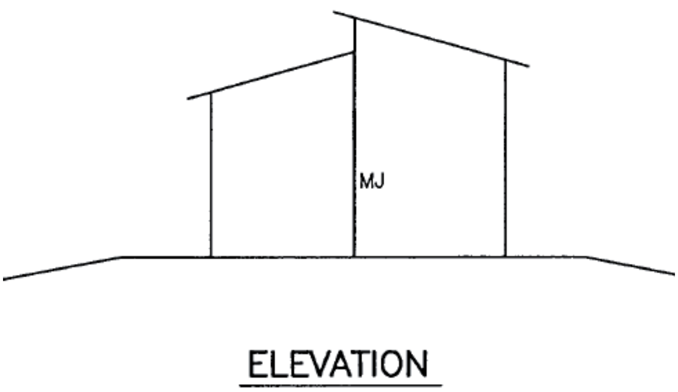
NOTE: As lintels require seating on both sides of openings, movement joints should not be placed in line with the sides of openings.



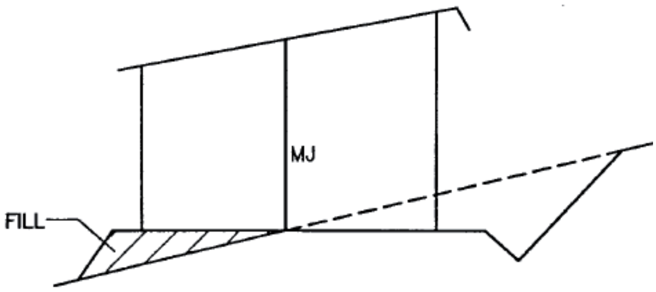
- **Walls built in dissimilar materials.**



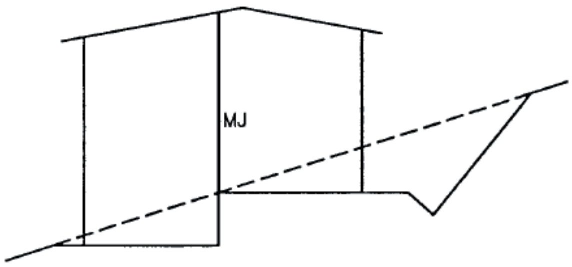
- **Geometrical change in wall height, i.e., single storey to two storey walls.**



- **Locations or junctions of different foundation types and steps in foundations.**

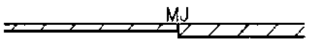


ELEVATION



ELEVATION

- **Change in wall thickness or junction of loadbearing and non-loadbearing walls.**



PLAN VIEW

Unless otherwise designed by a structural engineer, movement joints require shear connectors placed across the joints to maintain stability of the walls under lateral loads. Maximum vertical spacing of connectors is 400 mm. Approval of the connector spacing shall be provided by the appropriate structural engineer. Refer to: Part 6 for Construction Details and Part 8 for Fixing Capacities of the CSR Hebel Technical Manual; and Section 3 of the NZ Addendum on page I – 27.

Attention should be given to ensuring that these joints are kept free of all debris and mortar, and connectors installed in accordance with manufacturer's recommendations.

Importantly, in no circumstances should a movement joint be rendered across.

2.6 Bracing Design

General

Horizontal forces, such as wind and earthquake loading, applied to a building are to be resisted by bracing walls. Bracing walls are located generally at right angles to the walls subjected to these forces. All bracing components in the building shall be interconnected to adequately transfer the imposed loads. These connections are achieved in the following ways:

- The ceiling/floor/roof is designed to act as a diaphragm.
- The roof is appropriately held down (refer to Roof-Hold Down Design in CSR Hebel Technical Manual Part 6).
- Wall intersections are appropriately connected (refer to CSR Hebel Technical Manual Part 8).
- Load transfer to footings via reinforcement and dowels.

Distribution of Bracing Walls

Bracing walls shall be designed to resist the imposed loads determined in accordance with NZS 4229:1999, to ensure that lateral wind and earthquake forces from ceiling and floor diaphragms, and wall elements are adequately transferred into the foundations via internal and external bracing walls.

Bracing walls can be located at a maximum spacing of 8 metres. Note, the movement joint spacing (6 metres max.) may govern the bracing wall size and location.

Reinforcement Requirements of Bracing Walls

- Vertical reinforcement consists of reinforcement bars centrally located in 50mm diameter holes drilled on-site through the centre of the block wall width. After inserting the reinforcement, the holes are then filled for the full height of the wall with a 4:1 grout mix (i.e., 4 parts sand to 1 part cement), with a characteristic compression strength of 15MPa at 28 days. The following rules apply to positioning reinforcement bars along a length of wall:

    - Spaced at a maximum horizontal distance of 1000mm.
    - Located 150mm from the ends or corners of a run of wall, such as movement joints, vertical edge of windows and door openings, and external and internal corners.

- Horizontal reinforcement consists of a bond beam located at the top of the wall. Typically, the bond beam is reinforced with two reinforcement bars (12mm diameter) and filled with an aggregate grout. The grout shall have a characteristic compression strength of 15 to 20 MPa at 28 days. Reinforcement is to be designed and specified by the structural design engineer.

Details of typical walls are shown in Section 3 of the NZ Addendum.

Basic Load Data Used to Derive Tables

Weights of Components Used in the Earthquake Bracing Demand Evaluation.

Heavy roof	Concrete titles, timber roof trusses & ceiling	0.84kPa
Light roof	Steel sheeting timber trusses and ceiling	0.46kPa
CSR Hebel floor panel and floor covering loads		3.5kPa
Partitions – non-loadbearing		1.0kPa
All live loads as per NZS 4203		

Bracing Unit (BU) Demand Calculation.

Table 2.2, the Earthquake Bracing Unit (BU) Demand table expresses the BU demand in units per m^2 of a standard $7m^2$ box, used in the preparation of NZS4229 Table 4.3.

Total horizontal forces have been calculated from NZS4203 assuming:

$\mu = 1.25$
period of vibration < 0.6 seconds
site subsoil category (c) flexible or deep soil sites
$S_P = 0.67$
R = 1.0
Z = as appropriate for zones A (1.2), B (0.9), C (0.6)
$L_U = 1.0$

Bracing Demand Evaluation

The weights of the CSR Hebel blocks used in the earthquake bracing demand evaluation are presented in Table 2.1.

Table 2.1 – CSR Hebel Block Wall Weights

Type	Nominal Wall Thickness (mm)	Mass of Wall (kg/m^2)	Unit Weight of Wall (kN/m^2)	Factored Unit Weight of Wall (kN/m^2) (Note below)
Single Skin CSR Hebel Block Working Density 650kg/m^3 (Thermoblok)	150	100	1.0	1.1
	175	115	1.1	1.3
	200	130	1.3	1.5
	225	145	1.4	1.7
	250	165	1.6	1.9
	275	180	1.8	2.1
	300	195	1.9	2.3

NOTE: Factored unit weight is to be used in the NZ Addendum.

Bracing Unit Demand for CSR Hebel block walls subjected to an **Earthquake** shall be calculated in accordance with NZS 4229, using:

Table 2.2 – *Earthquake Bracing Demand for CSR Hebel Thermoblok Block Walls* **in place of** *NZS 4229 - Table 4.3*

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Table 2.2 – Earthquake Bracing Unit (BU) Demand for CSR Hebel Thermoblok Block Walls.

Single Storey Or Top Storey		**Concrete Slab On Ground**		
Building Description (with light roof)	**CSR Hebel Block Wall Thickness (mm)**	**Minimum Bracing Units /m² in Earthquake Zone**		
		A	**B**	**C**
Single Skin CSR Hebel Wall (650kg/m³)	150	19	14	9
	175	21	16	10
	200	23	17	12
	225	25	19	13
	250	28	21	14
	275	30	22	15
	300	32	24	16
For Heavy Roof	Add	5	4	3

Foundation Wall	**CSR Hebel Block Wall Thickness (mm)**	**Minimum Bracing Units /m² in Earthquake Zone**		
		A	**B**	**C**
Foundations 2m maximum height including suspended Hebel panel floors at ground and first floor.	Any	303	227	152

Note:

1) All values are based on using a 45° roof pitch
2) The heavy roof bracing demand is added directly to the Hebel wall values
3) All values relate to bracing demand for walls at lowest complete floor level
4) For bracing unit demands at first floor of 2 storey buildings use single storey figures
5) Foundation bracing unit demands are based on maximum possible demands from combinations of construction

Bracing Capacity - Background

Bracing Design

A masonry bracing wall with wide-spaced reinforcement can fail in four ways, as follows:

1. Shear failure of the material between reinforcing bars, as for an unreinforced wall. This is resisted by the shear strength of the masonry material.
2. Overturning of the wall as a whole about its toe. This is resisted by its self-weight, any vertical load from above, and the tie-down action of the vertical reinforcing bars.
3. Sliding on the base. This is resisted by friction at the base or damp-proof course layer, and dowel action of the vertical reinforcing bars where they cross the plane at the base of the wall.
4. Shear failure of the reinforced section, where shear cracks cross the reinforcing bars. This can be considered to be resisted by an enhanced shear capacity of the material, which takes into account the presence of the reinforcing steel.

In order to perform its function properly, a reinforced masonry bracing wall must have vertical steel reinforcing rods at each end of the wall and distributed along its length, and horizontal steel reinforcing at the top of the wall forming a bond beam. There is usually no requirement for horizontal steel at the bottom of the wall because the wall is firmly tied by the vertical steel to a slab or footing that is capable of performing the function of a bottom bond beam. The vertical and horizontal steel must be tied together to ensure proper location and action.

Development of the Bracing Capacity Tables

The bracing capacity tables in this manual give bracing capacities in bracing units for a range of wall sizes and conditions.

All reinforcement has been assumed to be M12 threaded rods with a yield strength of 300 MPa. The maximum spacing of vertical rods is 1000mm. Dowel action strength of the vertical rods has been taken as 6.75 kN per D12 reinforcement bar.

A bond beam must be included in all walls covered by the tables. No cases are governed by reinforced shear failure, but the bond beam should be included in all walls for shrinkage control. In every case the bond beam nominally consists of two D12 reinforcing bars located in the top course of the wall and tied to vertical reinforcement (refer Section 2.10). Reinforcement is to be designed and specified by a structural engineer.

The following approach has been used to generate the tables for this manual:

- Shear failure of the material (criterion 1, see above) has been checked using the approach of AS3700 (Clause 7.5.1(b)) but never governs for the range covered in the tables.
- Shear failure of the reinforced material (criterion 4, see above) has been checked using the approach of AS3700 (Clause 8.6) but never governs for the range covered in the tables.
- Overturning of the wall (criterion 2, see above) was checked and the load capacity calculated. This condition tends to govern for cases where the wall is relatively tall and short (with height/length greater than about 1).
- Sliding on the base (criterion 3, see above) was checked and the load capacity calculated. This condition tends to govern for cases where the wall is relatively long (with height/length less than about 1).

Designers can treat cases outside the range covered by the tables. In particular, this would be required to account for the effects of vertical load. However, if this is done, all four failure criteria set out above must be checked. Failure modes 1 and 4 can be checked by using the method given in AS3700 or another suitable approach. The approaches used to analyse failure modes 2 and 3 are set out below.

Design Procedure for Overturning

For the tables in this manual, calculation of the overturning capacity has been carried out by an analysis of the wall as a reinforced section cantilevered from the based. A capacity reduction factor of 0.75 has been used. Calculation of equilibrium for the section is based on a linear strain distribution and a maximum tensile strain in the extreme reinforcing bar of 0.0015. Figure 2.1 shows how the equilibrium of the section is determined. The rectangular stress block is taken to have a width of 0.85 times the depth to the neutral axis and a maximum stress of 0.85 times the characteristic compressive strength of the AAC masonry, f'_m.

Once the position of the neutral axis is determined, the overturning capacity is calculated by considering the moment generated by the compression stress block (ignoring any reinforcement in compression) and the reinforcement in the tension zone.

A more detailed analysis for individual cases would take account of any imposed load from above and the effect of any bonding of the wall to intersecting walls.

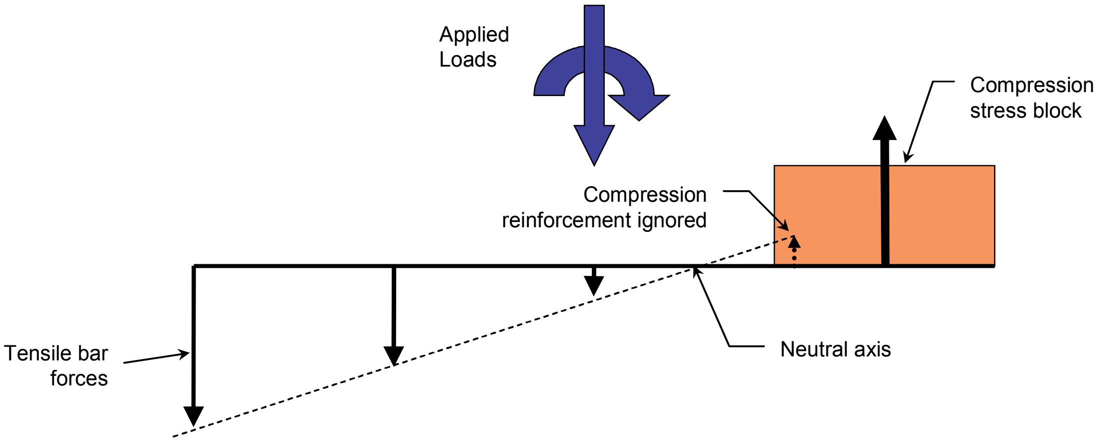


Figure 2.1. Equilibrium Calculation for Forces at Base of Bracing Wall

Design Procedure for Sliding

Analysis of the sliding capacity is based on a similar analysis of the reinforced section as illustrated in Figure 2.1, with a linear strain distribution through the section and a maximum tensile strain in the extreme reinforcing bar of 0.0015. As for overturning, the rectangular stress block is taken to have a depth of 0.85 times the depth to the neutral axis, and a compressive stress level of 0.85 f'_m.

Once the position of the neutral axis is determined, the sliding resistance is calculated as the sum of a friction component on the compression stress block and the dowel action of the bars. For the tables in this manual, the friction coefficient has been taken as 0.3 in accordance with AS3700 (Table 3.3). A capacity reduction factor of 0.75 has been used.

Bracing Capacity Tables

Adopt Tables 2.4 to 2.7 – Design Bracing (Shear) Capacities of CSR Hebel Walls (NZ Bracing Units) **in place of** NZS 4229, Table 5.2.

Table 2.4

Bracing (Shear) Capacity of 150mm thick CSR Hebel Block Walls

Wall Height (mm)	Bracing Capacity, BU (NZ Bracing Units)									
	Wall Length (mm)									
	900 (2 #D12)	1200 (2 #D12)	1800 (3 #D12)	2400 (3 #D12)	3000 (4 #D12)	3600 (5 #D12)	4200 (5 #D12)	4800 (6 #D12)	5400 (6 #D12)	6000 (7 #D12)
1200	210	310	480	480	640	800	800	960	960	1120
1400	180	270	480	490	640	800	800	960	970	1130
1600	160	230	480	490	650	800	810	970	970	1130
1800	140	210	430	490	650	810	810	970	970	1130
2000	130	190	390	490	650	810	810	970	980	1140
2200	120	170	350	490	650	810	820	980	980	1140
2400	110	160	320	460	650	810	820	980	990	1150
2600	100	140	300	420	660	820	820	980	990	1150
2800	90	130	280	400	620	820	830	990	990	1150
3000	80	130	260	370	580	820	830	990	1000	1160

Note: Bracketed information indicates ***minimum*** number of vertical reinforcement bars required.
20 Bracing Units (BU) = 1kN of Shear Force

150 mm

Table 2.5

Bracing (Shear) Capacity of 200mm thick CSR Hebel Block Walls

Wall Height (mm)	Bracing Capacity, BU (NZ Bracing Units)									
	Wall Length (mm)									
	900 (2 #D12)	**1200** (2 #D12)	**1800** (3 #D12)	**2400** (3 #D12)	**3000** (4 #D12)	**3600** (5 #D12)	**4200** (5 #D12)	**4800** (6 #D12)	**5400** (6 #D12)	**6000** (7 #D12)
1200	220	320	490	490	650	810	810	970	970	1130
1400	190	270	490	490	650	810	810	980	980	1140
1600	170	240	490	490	650	810	820	980	980	1150
1800	150	210	440	500	660	820	820	980	990	1150
2000	130	190	400	500	660	820	830	990	990	1160
2200	120	180	360	500	660	820	830	990	1000	1160
2400	110	160	340	470	670	830	830	1000	1000	1170
2600	100	150	310	440	670	830	840	1000	1010	1170
2800	90	140	290	410	650	830	840	1010	1010	1180
3000	90	130	270	390	610	840	850	1010	1020	1180

Note: Bracketed information indicates ***minimum*** number of vertical reinforcement bars required.
20 Bracing Units (BU) = 1kN of Shear Force

200 mm

Table 2.6

Bracing (Shear) Capacity of 250mm thick CSR Hebel Block Walls

Wall Height (mm)	Bracing Capacity, BU (NZ Bracing Units)									
	Wall Length (mm)									
	900 (2 #D12)	**1200** (2 #D12)	**1800** (3 #D12)	**2400** (3 #D12)	**3000** (4 #D12)	**3600** (5 #D12)	**4200** (5 #D12)	**4800** (6 #D12)	**5400** (6 #D12)	**6000** (7 #D12)
1200	230	320	490	500	660	820	820	980	980	1140
1400	190	280	500	500	660	820	820	990	990	1150
1600	170	240	500	500	660	820	830	990	1000	1160
1800	150	220	450	500	670	830	830	1000	1000	1170
2000	140	200	410	510	670	830	840	1000	1010	1170
2200	120	180	380	510	670	840	840	1010	1020	1180
2400	110	170	350	490	680	840	850	1010	1020	1190
2600	110	150	320	450	680	850	850	1020	1030	1190
2800	100	140	300	430	670	850	860	1030	1040	1200
3000	90	130	280	400	630	850	860	1030	1040	1210

Note: Bracketed information indicates ***minimum*** number of vertical reinforcement bars required.
20 Bracing Units (BU) = 1kN of Shear Force

250 mm

Table 2.7

Bracing (Shear) Capacity of 300mm thick CSR Hebel Block Walls

Wall Height (mm)	Bracing Capacity, BU (NZ Bracing Units)									
	Wall Length (mm)									
	900 (2 #D12)	**1200** (2 #D12)	**1800** (3 #D12)	**2400** (3 #D12)	**3000** (4 #D12)	**3600** (5 #D12)	**4200** (5 #D12)	**4800** (6 #D12)	**5400** (6 #D12)	**6000** (7 #D12)
1200	230	330	500	500	660	820	830	990	990	1160
1400	200	280	500	500	670	830	830	1000	1000	1160
1600	170	250	500	510	670	830	840	1000	1010	1170
1800	150	220	460	510	670	840	850	1010	1020	1180
2000	140	200	420	510	680	840	850	1020	1020	1190
2200	130	180	380	520	680	850	860	1020	1030	1200
2400	120	170	350	500	690	850	860	1030	1040	1210
2600	110	160	330	470	690	860	870	1040	1050	1220
2800	100	150	310	440	690	860	870	1040	1050	1220
3000	90	140	290	410	650	870	880	1050	1060	1230

Note: Bracketed information indicates ***minimum*** number of vertical reinforcement bars required.
20 Bracing Units (BU) = 1kN of Shear Force

300 mm

2.7 Vertical Load Capacity of Walls

The ultimate vertical load capacity of reinforced CSR Hebel loadbearing block walls can be determined conservatively from Charts CP1 to CP24 in Part 6.7 of the CSR Hebel Technical Manual.

These are based on un-reinforced walls constructed with CSR Hebel Thin Bed Adhesive, following the requirements outlined in Section 7.3 of the Australian Standard AS 3700-2001: *Masonry Structures*.

2.8 Lateral Load Capacity of Spanning Walls

Although not required by NZS 4229, the load capacity of CSR Hebel block walls should be checked for out-of-plane lateral wind and earthquake loads.

The ultimate out-of-plane bending capacity of reinforced CSR Hebel loadbearing block walls can be determined conservatively from Charts BD1 to BD15, in Part 6.8 of the CSR Hebel Technical Manual, for un-reinforced block walls.

These are based on un-reinforced walls constructed with CSR Hebel Thin Bed Adhesive, following the requirements outlined in Section 7.4 of the Australian Standard AS 3700-2001: *Masonry Structures*. CSR Hebel suggests designing the wall thickness, such that the wall spans vertically with no influence of vertical edge restraint (from intersecting walls or returns). This will allow movement joints to be be positioned later without detrimentally affecting the design lateral load capacity of the wall.

2.9 Diaphragm Design

Structural diaphragms at roof, ceiling or floor level, which provide lateral support to CSR Hebel block walls against horizontal wind and earthquake loads should be designed in accordance with NZS 4229.

In using NZS 4229, Table 9.1 – Nail fixing for ceiling and roof diaphragms, CSR Hebel Masonry walls should be considered to be “P” (partially filled).

2.10 Bond Beams

Where earthquake or wind loads are transmitted through diaphragm action of floors and roofs, which would be the case in the majority of situations, a continuous bond beam shall be provided at the top of all external and internal walls of all single level buildings. Bond beams shall be a minimum of 200 mm deep and of the same width as the blockwall, including AAC facings.

Bond beams can be easily constructed using 50mm wide AAC closure blocks fixed to the top of the blockwall with thin bed adhesive. Nominally two D12 reinforcement bars are then place centrally in the core and grout filled. Reinforcement shall be designed and specified by a structural engineer. Refer to Section 3 – Construction Details.

2.3 It is not advisable to use high tensile steel for the vertical reinforcingor the bond beam reinforcement as the use of high tensile steel with low compressive strength concrete could lead to an explosive failure of the concrete. It is not balanced design philosophy to use high strength steel in low strength concrete.

2.4 A suitably qualified structural engineer shall perform the bracing design. An appropriate bond beam, having the required strength and stiffness to transmit the horizontal forces shall form part of all bracing walls.

2.11 Residential Footing System Designs for CSR Hebel Blockwork

External and internal Hebel blockwork walls shall be constructed on appropriately proportioned reinforced strip footings or stiffened raft slabs on ground.

Where buildings meet the requirements of NZS 4229:1999 *Concrete Masonry Buildings Not Requiring Specific Engineering Design*, and are founded on either rock, sand or any other bearing strata that does not exhibit seasonal movement, then strip footings can be proportioned to comply with Section 6 of NZS4229.

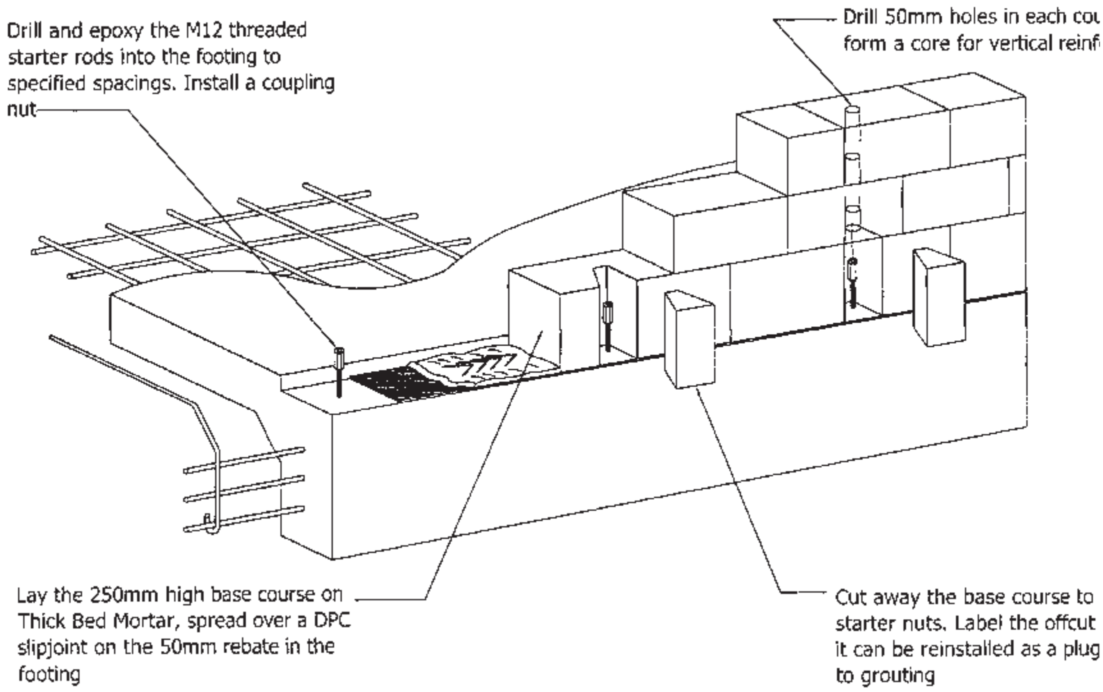
Where buildings are not founded on bearing strata noted above, or where it is decided to use integrally cast stiffened raft or slab-on-ground footing system, then the selection of the foundation type shall be based on the recommendations outlined in AS2870.1: 1996 "*Residential Slabs and Footings*". This standard covers the selection of footing designs for the usual range of site conditions, soil types and slopes. Where unusual site or load conditions are encountered, advice should be obtained from a practicing Structural Engineer.

Section 3: CONSTRUCTION DETAILS – SINGLE STOREY CONSTRUCTION

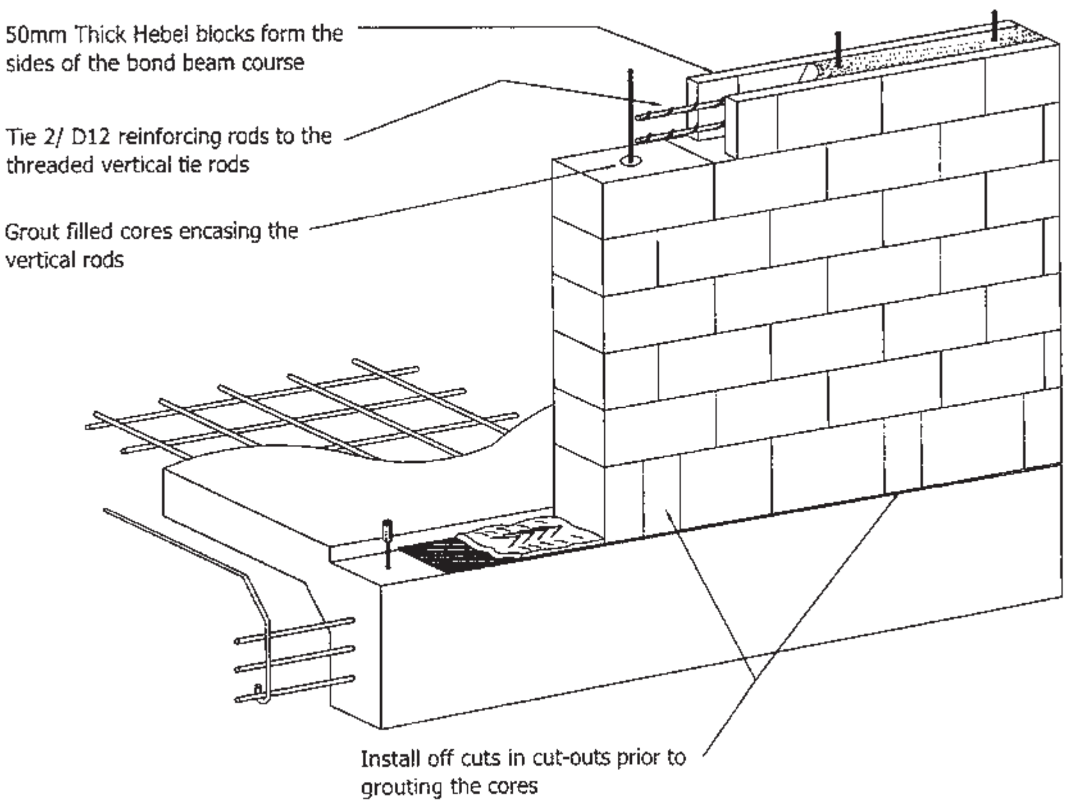
(To be read in conjunction with CSR Hebel Technical Manual)

1. **Set Out of “Block Outs” for Coupling the Reinforcement Bars**
2. **Typical Construction of a Bond Beam**
3. **Reinforced Wall - Connection to Footing Detail**
4. **Typical Bond Beam Over Window Detail**
5. **Typical Top Bond Beam Detail**
6. **Movement Control Joint Detail**

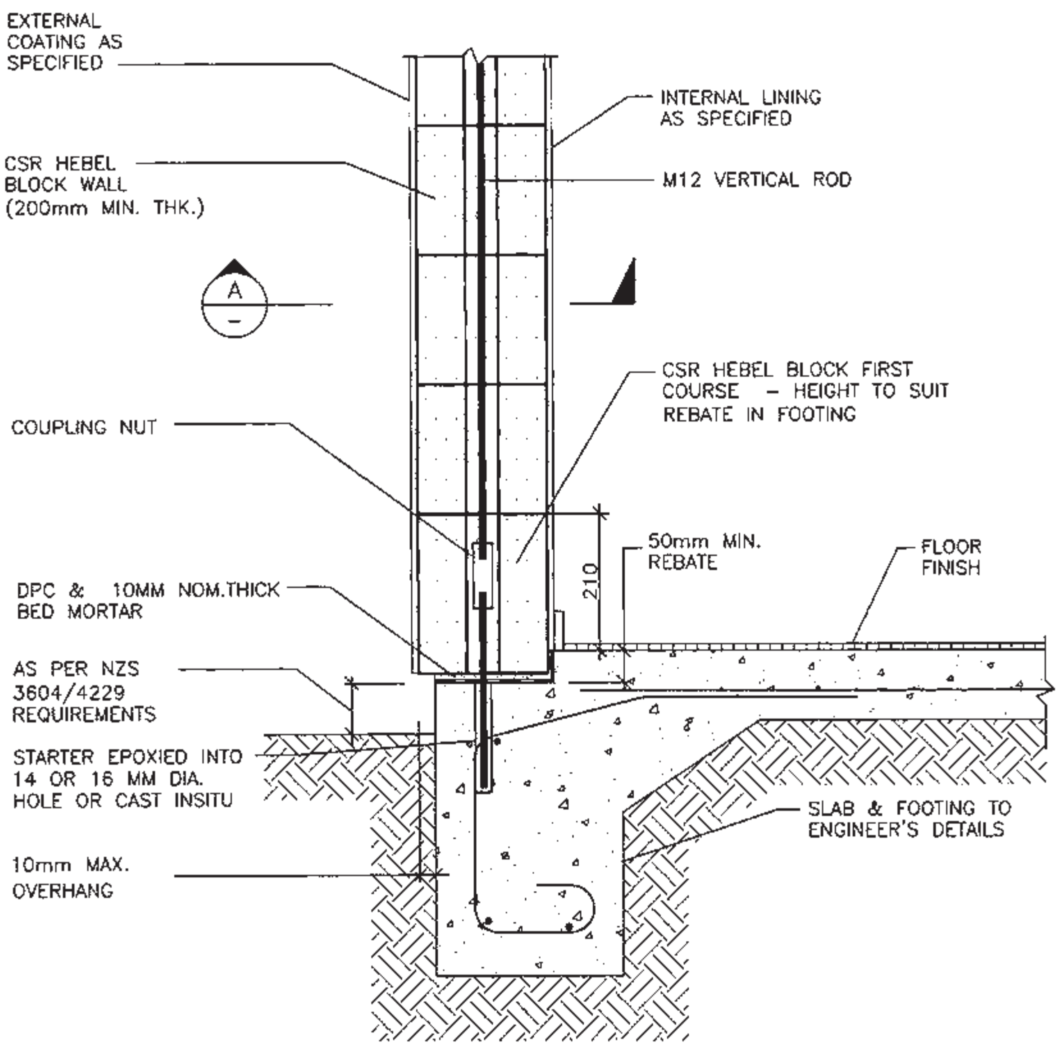
Base Course Setout for Block Walls

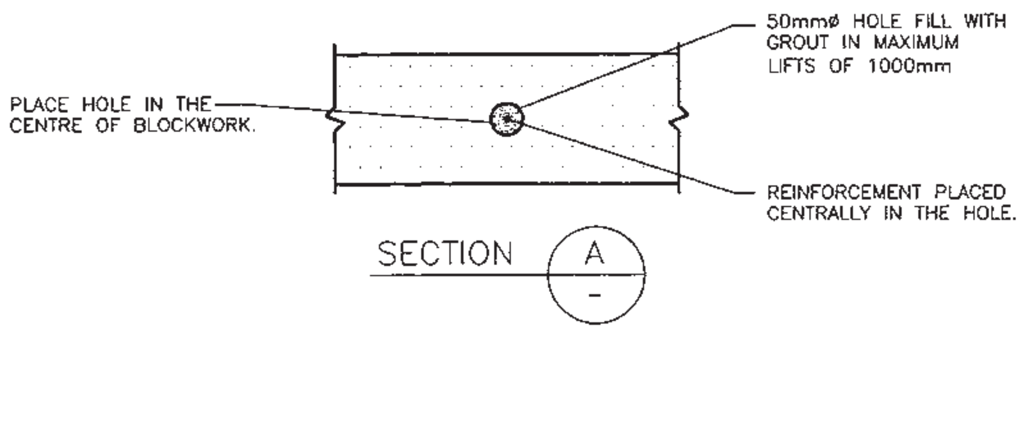


Bond Beam Top Course for Block Walls

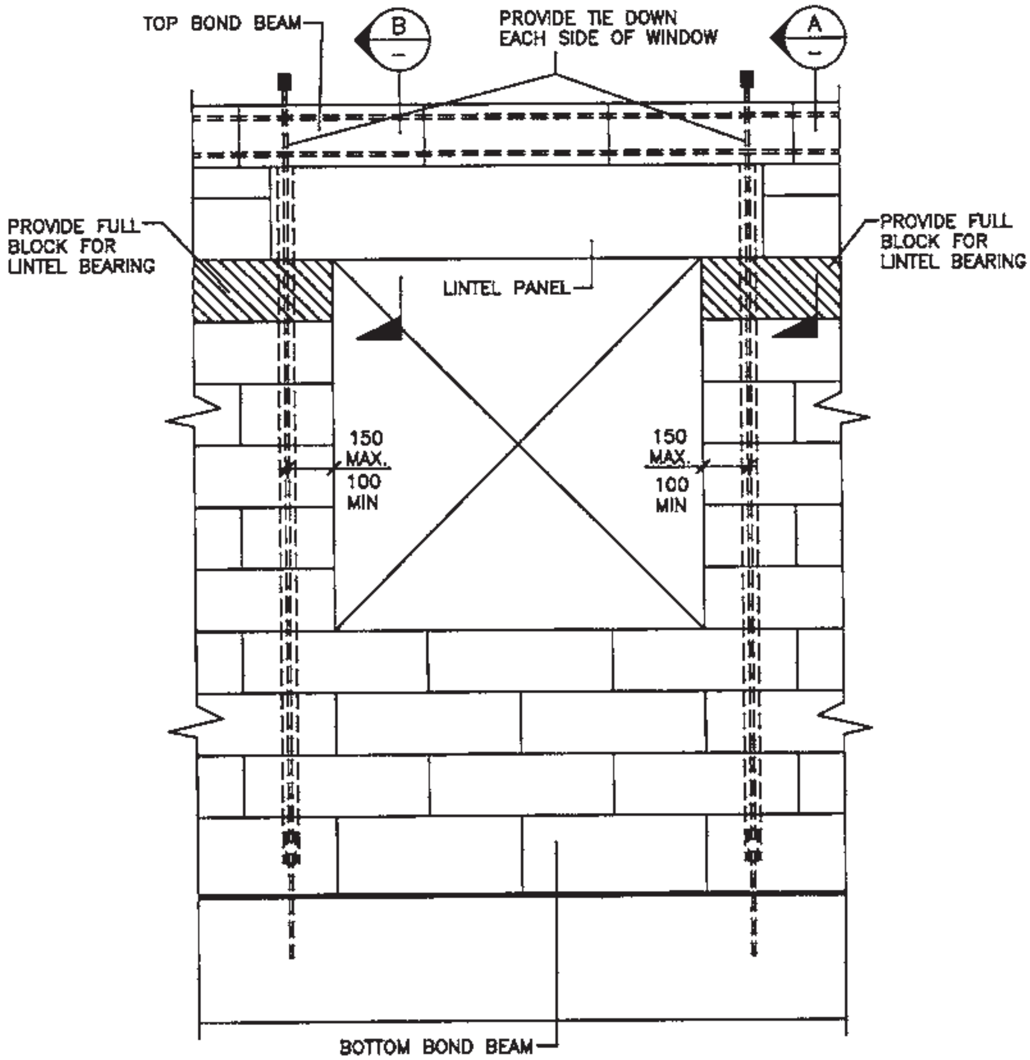


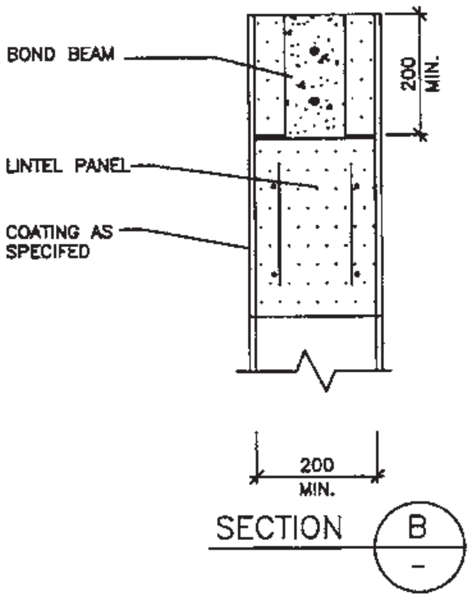
Reinforced Wall-Connection To Footing Detai

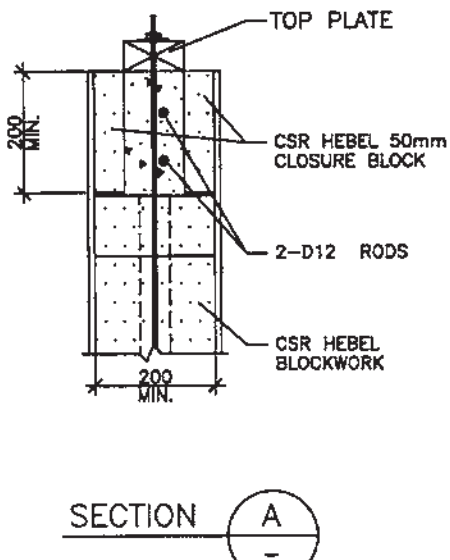




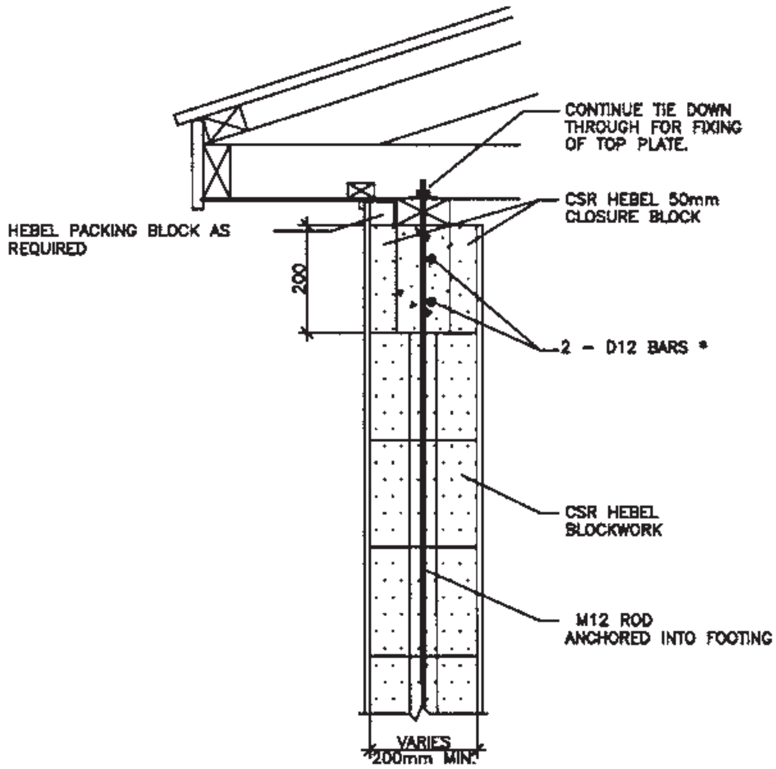
Typical Bond Beam Over Window Detail



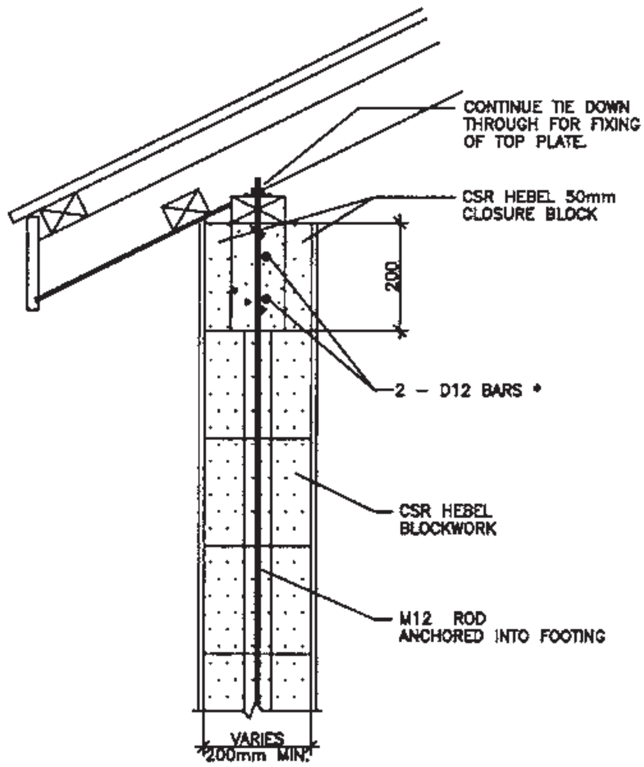




Typical Top Bond Beam-External Walls (No Openings)

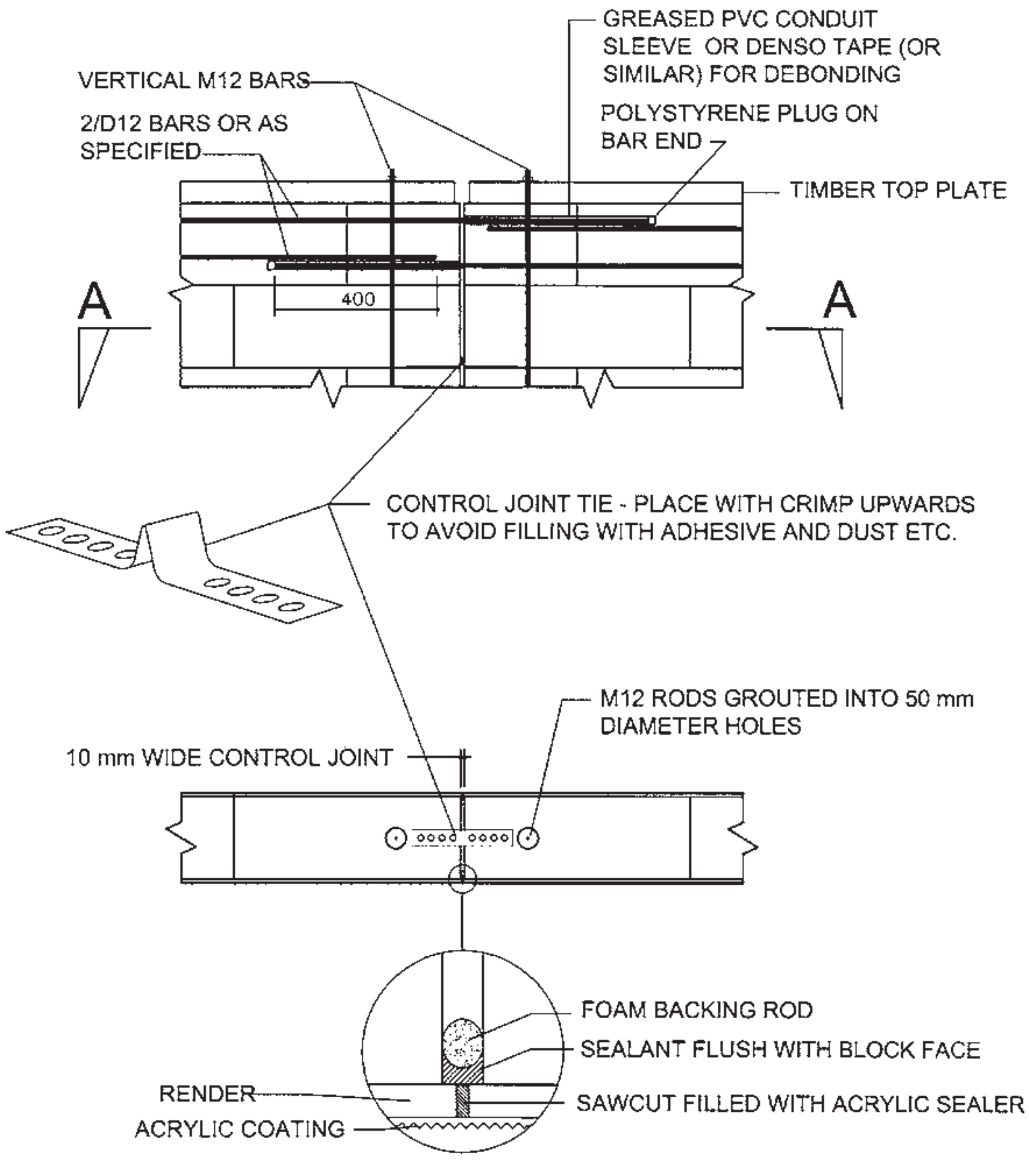


Horizontal soffit



Raking soffit

Movement Control Joint Details



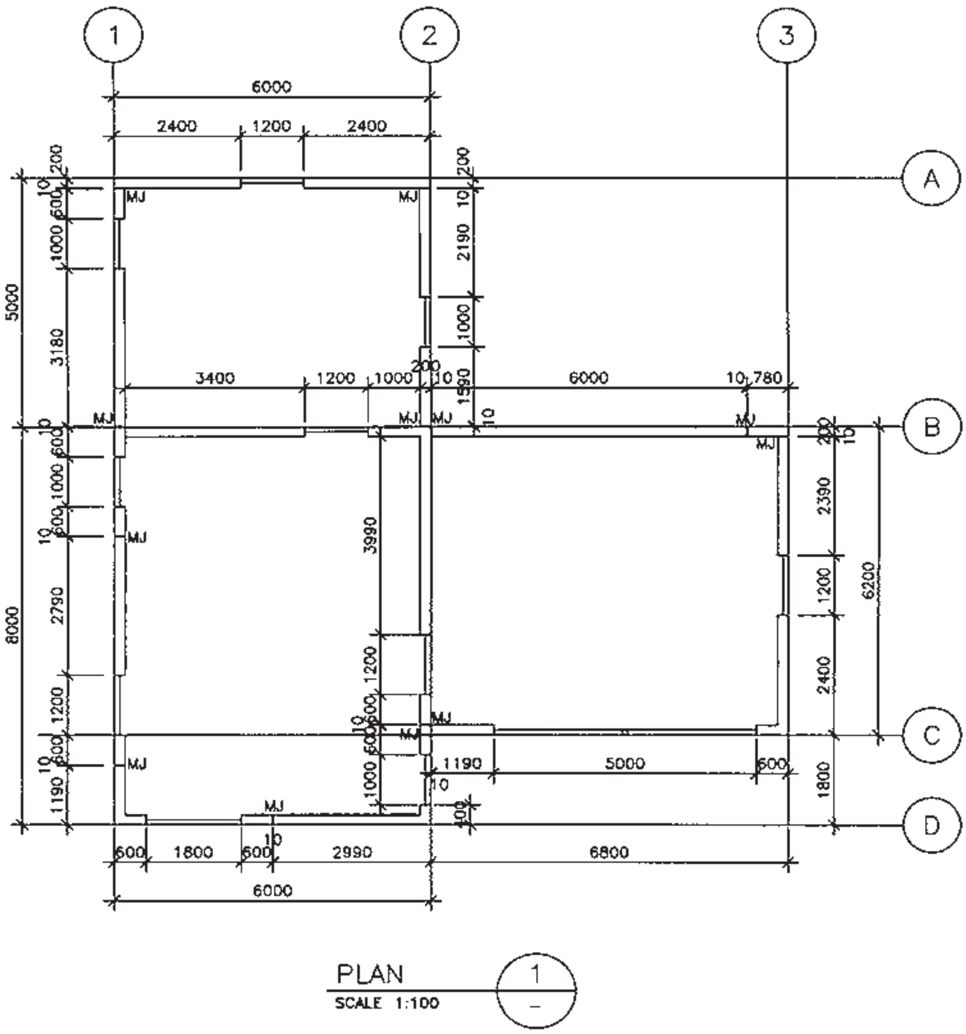
Section A-A

NOTE: To create the break in the bond beam, use a 10 mm thick piece of polystyrene as formwork and punch the reinforcing through it. Dissolve out afterwards with solvent to allow free joint movement.

Section 4: DESIGN EXAMPLE – SINGLE STOREY CONSTRUCTION

A single storey house located in Earthquake Zone A is constructed with 2400mm high x 200mm thick external CSR Hebel Thermoblok block walls and a light roof. The ridge height is 3000mm.

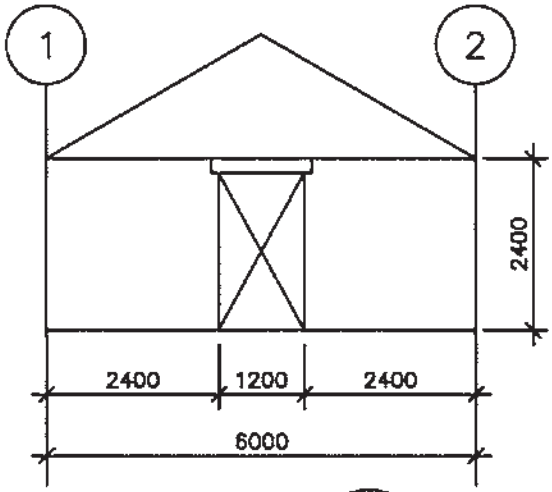
This is a simplified design to illustrate the design of the bracing walls; the following design aspects have been excluded: foundation design, connection design and assessment of site compliance.



WALL LAYOUT – PLAN VIEW

The “Wall Layout” configuration shown is used to illustrate the bracing capacity calculation.

IMPORTANT: It is the designer’s responsibility to check the adequacy of the walls and allow for the effects of applied loads, movement of the structure, movement joints, chasing, arrangement of openings, strength, fire resistance and robustness.



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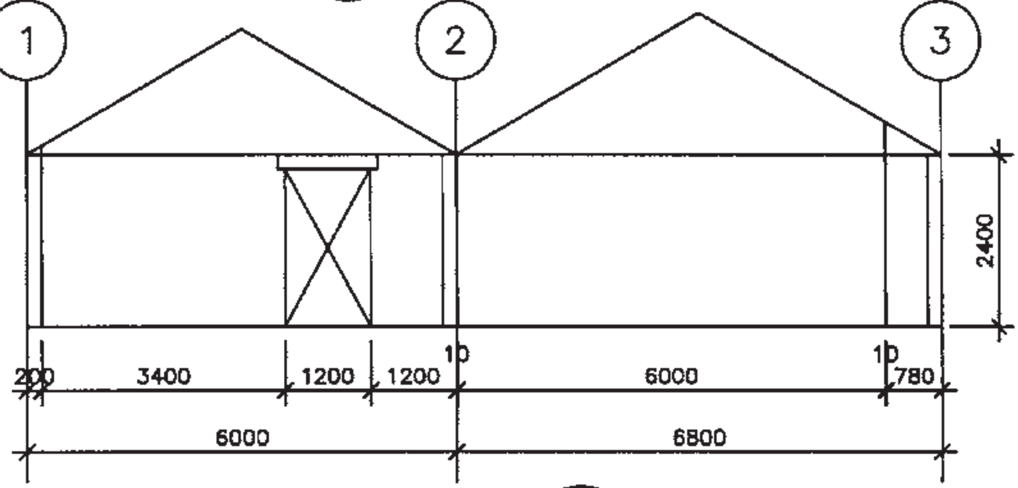
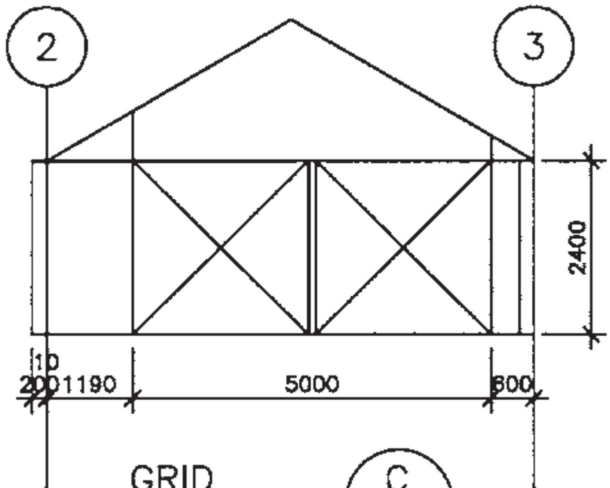
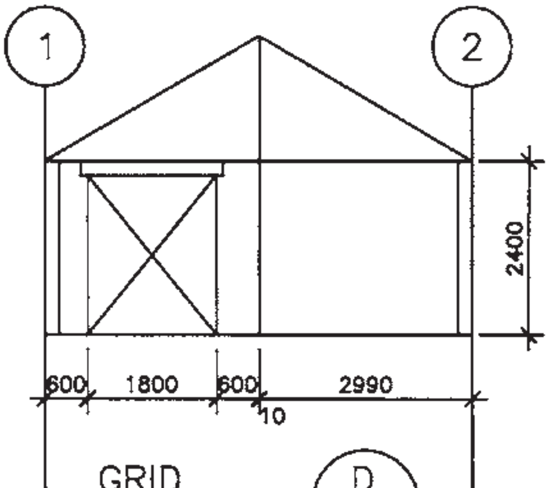


GRID B
SCALE 1:100 –



GRID C
SCALE 1:100 –



GRID D
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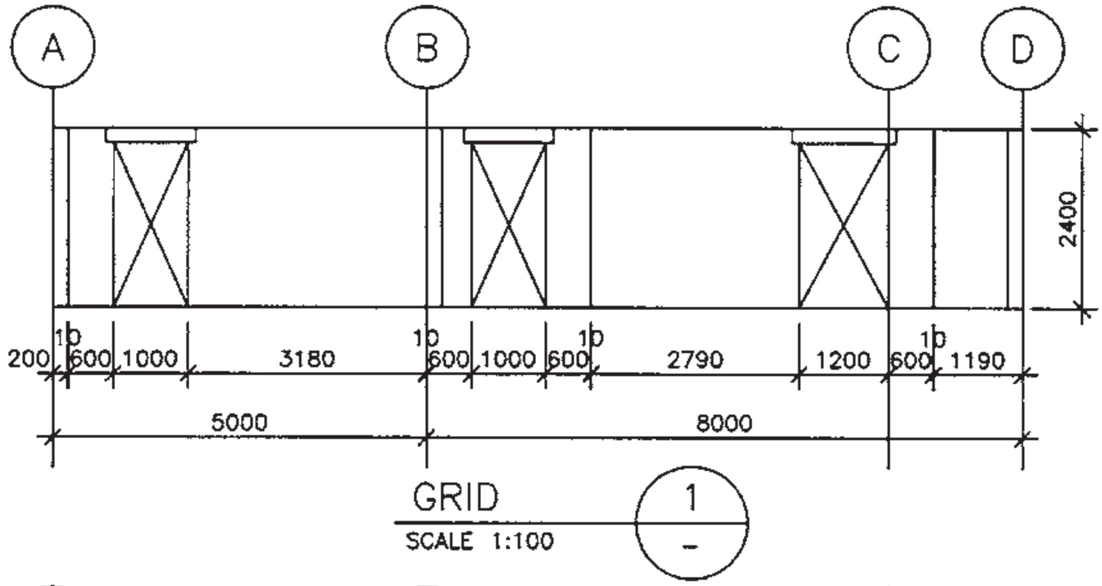
A
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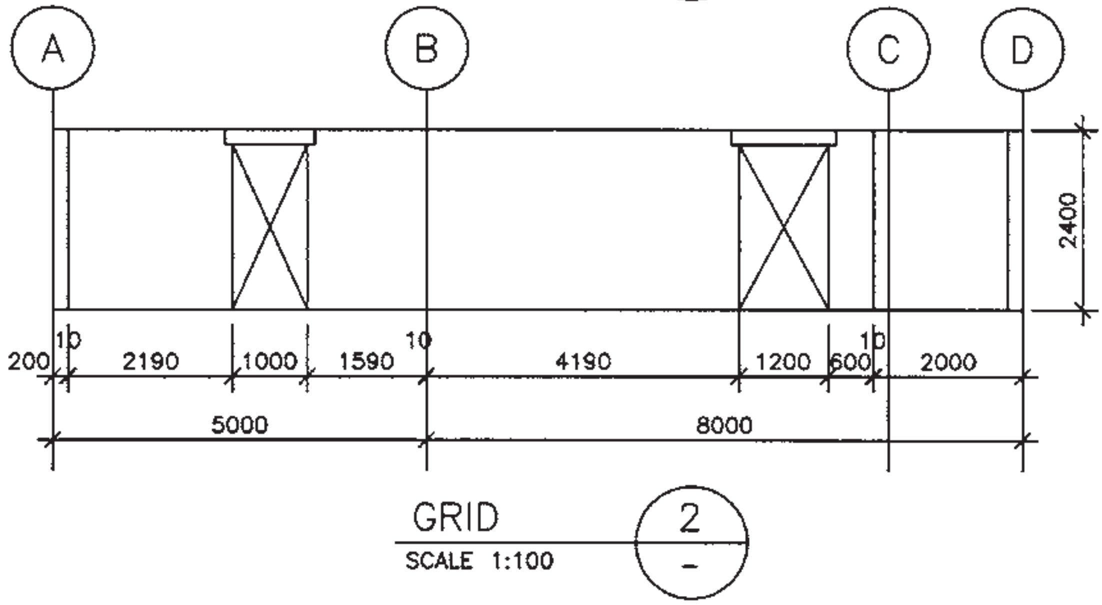
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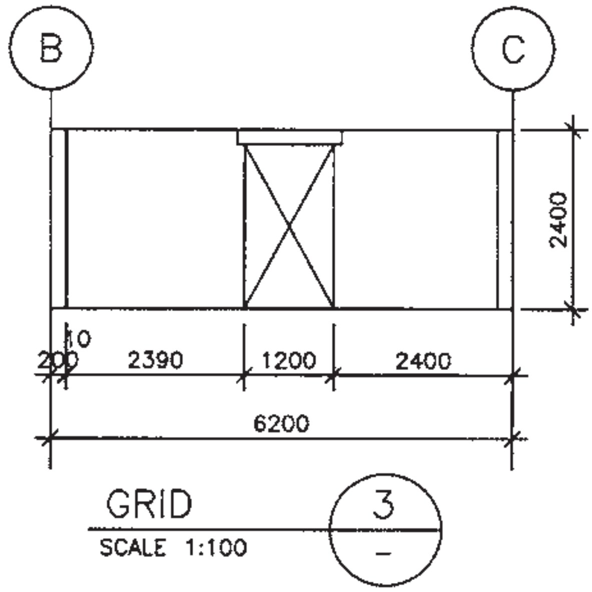
B
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6200
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–

Step 1 – Wall Bracing Demand Evaluation

NZS 4229 Fig 4.1

Step 1A – Determination Earthquake Zone

NZS 4229 Table 4.1

→ Earthquake Zone A

EQ Zone A

Step 1B – Determine Bracing Unit demand for earthquake loading

Hebel NZ Adden. Table 2.2

→ Demand = 23 BU/m^2 (200mm thick Thermoblok external wall)

EQ demand 23 BU/m^2

Step 1C – Determine total bracing demand for earthquake loading

Plan Area = 120.2m^2

→ EQ Demand = 120.2 x 23 = 2765 BU

EQ demand 2765 BU's

Step 1D – Determine bracing demand loading for wind loading

Single storey structure, storey height = 2.4m and height to apex < 10m

Wind demand

NZS 4229 Table 4.2

→ Demand across ridge = 111 BU/m

111 BU/m across

NZS 4229 Table 4.2

→ Demand along ridge = 111 BU/m

111 BU/m along

Step 1E – Determine total bracing demand for wind loading

Wall length across ridge = 13m

→ Total wind demand across ridge = 111 x 13 = 1442 BU

1442 BU's across

Wall length along ridge = 6 + 6.8 = 12.8m

→ Total wind demand along ridge = 111 x 12.8 = 1421 BU

1421 BU's along

Step 1F – Determine total bracing demand

Earthquake demand = 2765 BU's

Worst case wind demand = 1442 BU's

→ Earthquake loading governs

Design demand 2765 BU's

Step 2 – Determine Bracing Capacity

Two approaches for assessing the bracing strength of the walls in the example are illustrated. These are Individual Diaphragms Approach and Bracing Line Approach.

APPROACH 1 | ***Individual Diaphragms Approach***

***Step 2A** – Determine bracing lines, location of movement joints (C.J or A.J.) and bracing panels*

Refer to figures showing bracing lines, movement joints and bracing panels.

***Step 2B** – Determine required minimum capacity of individual bracing lines*

In general each wall has to support a minimum of 60% of the total bracing demand, although this can be reduced to 30% where the opposite wall can be shown to resist 100%.

Diaphragm	Plan Area (m^2)	Total Bracing Demand (BU's)	60% of Demand (BU's)
D1	6 x 5.0 = 30.0	690	414
D2	6 x 8.0 = 48.0	1104	663
D3	6.8 x 6.2 = 42.2	971	583

***Step 2C** - Determine bracing capacity of each bracing line*

Grid A

Hebel NZ Adden. Table 2.4

Bracing Line	Panel Height (m)	Panel Length (m)	Bracing Capacity (BU's)
A	2.4	2.4	470
	2.4	2.4	470
			940

Capacity of Grid A is 940 BU's exceeding the demand of 414 BU's

→ Bracing Line Grid A OK

Bracing Line Grid A OK

Grid B

Diaphragm D3

Bracing capacity of wall on Grid C < 30% of demand, therefore 100% of demand carried by wall on Grid B.

100% of bracing demand = 971 BU's

Diaphragms D1 and D2

Hebel NZ Adden. Table 2.4

Bracing Line	Panel Height (m)	Panel Length (m)	Bracing Capacity (BU's)
B	2.4	3.39	776
	2.4	1.2	160
	2.4	6.0	1170
			2106

Grid B internal bracing wall is common to diaphragms D1 and D2, then the bracing demand is taken as 40% of the sum of total bracing demands of diaphragms D1 and D2.

Grid B external bracing wall for diaphragm D3 bracing demand is taken as 100% of the bracing demand of diaphragm D3.

Grid B demand = 0.4 x (690 + 1104) + 971 = 1689 BU's

Grid B Capacity is 2106 BU's exceeding the total demand of 1689 BU's

OK

→ Bracing Line Grid B OK

Bracing Line Grid B OK

Grid C

Hebel NZ Adden. Table 2.4

Bracing Line	Panel Height (m)	Panel Length (m)	Bracing Capacity (BU's)
C	2.4	1.19	160
			160

Capacity of Grid C is 160 BU's which is less than 292 BU's (30% of the demand of 971 BU's)

OK

Bracing load carried by Bracing Line Grid B

Bracing Line Grid C OK

Grid D

Hebel NZ Adden. Table 2.4

Bracing Line	Panel Height (m)	Panel Length (m)	Bracing Capacity (BU's)
D	2.4	2.99	670
	2.4	3.0	670
			1340

Capacity of Grid D is 1340 BU's exceeding the demand of 663 BU's

→ Bracing Line Grid D OK

Bracing Line Grid D OK

Grid 1

Hebel NZ Adden. Table 2.4

Bracing Line	Panel Height (m)	Panel Length (m)	Bracing Capacity (BU's)
1	2.4	3.18	736
	2.4	2.79	603
	2.4	1.19	160
			1499

Grid 1 external bracing wall is common to diaphragms D1 and D2, hence the bracing demand is taken as 60% of the sum of total bracing demands of diaphragms D1 and D2.

Grid 1 demand = 0.6 x (690 + 1104) = 1077 BU's

Capacity of Grid 1 is 1499 BU's exceeding the demand of 1077 BU's

→ Bracing Line Grid 1 OK

Bracing Line Grid 1 OK

Grid 2

Hebel NZ Adden. Table 2.4

Bracing Line	Panel Height (m)	Panel Length (m)	Bracing Capacity (BU's)
2	2.4	2.19	426
	2.4	1.59	280
	2.4	4.19	830
	2.4	2.0	383
			1919

Grid 2 external bracing wall supports diaphragms D1, and internal bracing wall common to diaphragms D2 and D3, then the bracing demand is taken as the sum of 60% of diaphragm D1 and 40% of the sum of total bracing demands of diaphragms D2 and D3.

Grid 2 demand = 0.6 x 690 + 0.4 x (1104 + 971) = 1244 BU's

Capacity of Grid 2 is 1919 BU's exceeding the demand of 1244 BU's

→ Bracing Line Grid 2 OK

Bracing Line Grid 2 OK

Grid 3

Hebel NZ Adden. Table 2.4

Bracing Line	Panel Height (m)	Panel Length (m)	Bracing Capacity (BU's)
3	2.4	2.4	470
	2.4	2.4	470
			940

Capacity of Grid 3 is 940 BU's exceeding the demand of 583 BU's

→ Bracing Line Grid 3 OK

Bracing Line Grid 3 OK

Step 2D *– Check bracing capacity of overall building*

Bracing Direction	Panel Height (m)	Panel Length (m)	Bracing Capacity (BU's)
Across Ridge	2.4	2.40	470
	2.4	2.40	470
	2.4	3.39	776
	2.4	1.20	160
	2.4	6.00	1170
	2.4	2.99	670
	2.4	3.00	670
			4386
Along Ridge	2.4	2.79	603
	2.4	1.19	160
	2.4	2.19	426
	2.4	1.59	280
	2.4	3.98	830
	2.4	2.40	470
	2.4	2.00	383
	2.4	2.40	470
	2.4	2.4	470
			4092

Step 2E *– Conclusion*

Overall Capacity of Across Ridge is 4386 BU's exceeding the demand of 2765 BU's

Bracing capacity across ridge is OK

Overall Capacity of Along Ridge is 4092 BU's exceeding the demand of 2765 BU's

Bracing capacity along ridge is OK

It was established that sufficient individual and overall bracing capacity has been provided for the house.

→ House has sufficient bracing capacity

Bracing Capacity OK

APPROACH 2 *Bracing Line Approach*

Step 2A *– Determine bracing lines, location of shrinkage control joints and bracing panels*

Refer to figures showing bracing lines, control joints and bracing panels.

Step 2B *– Determine bracing demand of individual bracing lines*

The Critical loading case was earthquake, where the bracing demand was 23 BU/m^2

Hebel NZ Adden. Table 2.2

→ Demand = 23 BU/m^2

Demand 23 BU/m^2

The bracing demand of the bracing line is determined by multiplying the Bracing Demand by the plan area supported by the bracing line.

The plan area is taken as the wall length multiplied by the tributary width of the diaphragm/s supported by the wall.

The bracing demand of individual bracing lines are shown in the table below.

Bracing Line	**Tributary Width (m)**	**Wall Length (m)**	**Demand of Bracing Line (BU's)**
A	5 ÷ 2 = 2.5	6.0	23 x 2.5 x 6 = 345
B	(5+ 6.2) ÷ 2 = 5.6	12.8	23 x 5.5 x 12.8 = 1649
C/D*	8 ÷ 2 = 4	12.8	23 x 4 x 12.8 = 1178
1	6 ÷ 2 = 3	13	23 x 3 x 13 = 897
2	(6 + 6.8) ÷ 2 = 6.4	13	23 x 6.4 x 13 = 1914
3	6 ÷ 2 = 3	6.2	23 x 3 x 6.2 = 428

NZS 4229

* Treat as a single wall as offset is less than 2m. The tributary width is determined from the larger diaphragm width.

Step 2C *- Determine bracing capacity of each bracing line*

The total bracing capacity provided by the individual panel/s along a bracing line can be determined as outlined in the *Individual Diaphragm Approach* and are listed in the table below.

Hebel NZ Adden. Table 2.4

Bracing Line	**Bracing Capacity (BU's)**
A	470 + 470 = 940
B	776 + 160 + 1170 = 2106
C/D*	160 + 670 + 670 = 1500
1	736 + 603 + 160 = 1499
2	426 + 280 + 830 + 383 = 1919
3	470 + 470 = 940

NZS 4229

* Treat as a single wall as offset is less than 2m. The total bracing capacity is taken as the sum of the bracing capacities for the individual panels of both Grids C and D.

Step 2D *– Check adequacy of bracing lines*

Bracing Line	Bracing Demand (BU's)	Bracing Capacity (BU's)	Remark
A	345	940	✓ OK
B	1649	2106	✓ OK
C/D*	1178	1500	✓ OK
1	897	1499	✓ OK
2	1914	1919	✓ OK
3	428	940	✓ OK

Step 2E *– Conclusion*

It has shown that sufficient individual and overall bracing capacity has been provided for the house.

→ House has sufficient bracing capacity

Bracing Capacity OK

Step 3 – Determine Wall Reinforcement

The minimum reinforcement requirements of the bracing walls are outlined in Section 2.6 of the NZ Addendum.

Construction details illustrating the configuration of reinforcement at footings, bond beams, lintels and movement joints are presented in Section 3 of the NZ Addendum and Part 6 of the CSR Hebel Technical Manual.

Step 4 – Design Ceiling Diaphragm

The need for a ceiling diaphragm and construction details of the diaphragm can be established from Section 9 of NZS 4229.

Step 5 – Bond Beam Design

The design of bond beams shall be determined from Section 2.10 of the NZ Addendum.

Construction details are available in Part 3 of the NZ Addendum.

Step 6 – Lintel Design

The design of AAC lintels shall be determined from Section 6.11 of the CSR Hebel Technical Manual.

Construction details are available in Part 3 of the NZ Addendum.

***Step 6A** – Determine whether CSR Hebel lintel suits application*

Check that the available range of lintels (widths and lengths) suits the opening width and sufficient end bearing support of the lintel (200-300mm).

Openings with a clear span in excess of 2400mm will require a galvanised steel lintel or cast in-situ concrete lintel designed by the project engineer (or other).

N.B. Allowance must be made for the course height of the continuous bond beam over the AAC lintel.

***Step 6B** – Determine weight of roof*

Hebel NZ Adden. Section 2.6

Light roof has a dead load of 0.46kPa and a maximum span of 6m.

Roof weight

NZS 4229 Fig 6.1

→ Dead load (DL) weight = 6 ÷ 2 x 0.46 kPa = 1.38kN/m — 1.38kN/m (DL)

→ Live load (LL) weight = 6 ÷ 2 x 0.25 kPa = 0.75kN/m — 0.75kN/m (LL)

→ DL + LL = 2.13kN/m — 2.13kN/m (DL+LL)

***Step 6C** – Lintel Selection*

Clear Span of Lintel = 2400mm

Width of Blocks in Wall = 200mm

Fire Rating Level = 0 minutes

Tech.Manual. Table 6.14

Minimum End Bearing = 300mm

Minimum Length of Lintel = 2400 + 300 x 2 = 3000mm

Tech.Manual. Table 6.15

Select 3000mm long x 400mm high x 100mm wide lintel with capacity of 9.3kN/m.

Capacity of Lintel is 9.3 kN/m exceeding the roof load of 2.13kN/m.

→ Selected lintel OK

3m long x 100mm thick std. Lintel OK

Whilst load capacity is OK, the height of 400mm prevents this AAC lintel from fitting in under the bond beam. Design an in-situ concrete lintel as per NZS3101.

Step 7 – Footing Design

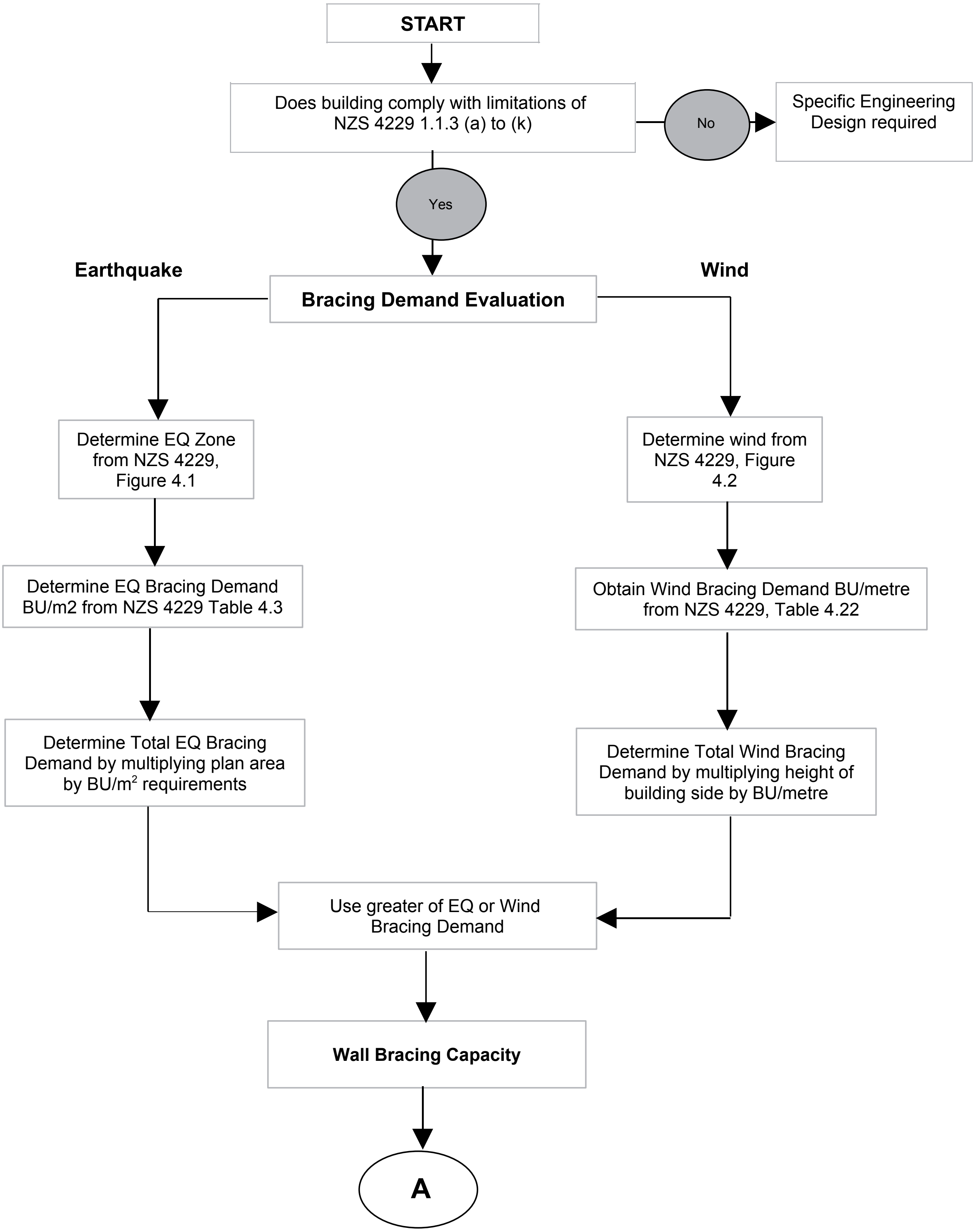
Step 7A – Determine wall weights

Walls constructed from 200mm thick CSR Hebel block units

Hebel NZ Adden. Table 2.1	→ Factored unit weight of wall = 1.5kN/m^2	
	Wall height 2.4m	
	→ Factored weight of wall (1.5 x 2.4) = 3.6kN/m	Weight of wall is 3.6kN/m
	Step 7B – Consider wall axial load at foundation	
	Weight on footing for walls supporting roof system	
	→ Total factored weight on footing = 2.13 + 3.6 = 5.73kN/m	Load on footing is 5.73kN/m
	Weight on footing at gable end does not have a roof load, but need to allow for gable.	
	→ Total factored weight on footing = (2.4 + (3 - 2.4) ÷ 2) x 1.5 = 4.05kN/m	Load on footing is 4.05kN/m
	Critical design weight on footing is from the wall supporting the roof system.	
NZS 4229 Table 8.1	Weight on footing less than limiting wall capacity of 68kN/m.	
	→ Wall load capacity OK	Wall load capacity OK
	Step 8 – Detail Footing	
	***Step 8A** - NZ standard footing detail*	
NZS 4229 Table 6.2	Weight on footing = 5.73kN/m, hence footing details are:	
	A single storey house located in Earthquake Zone A is constructed on a stiffened concrete raft slab.	
	***Step 8B** - Conclusion*	
	Width = 400mm	
	Depth = 300mm	
	Reinforcement 2 D-12, with R6 stirrups @ 600 c/c	

Section 5: HEBEL DESIGN FLOWCHART

SINGLE STOREY CONSTRUCTION



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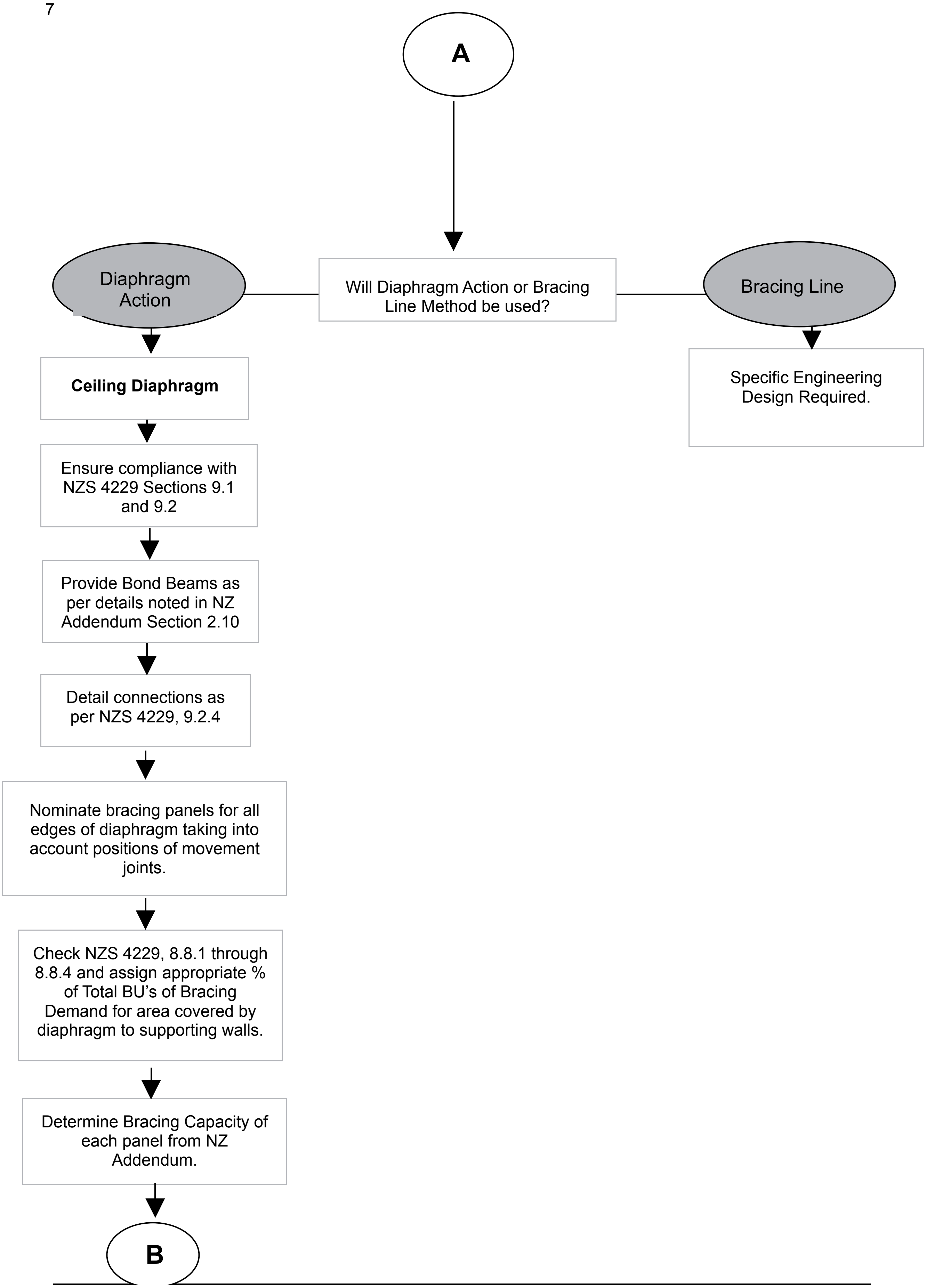
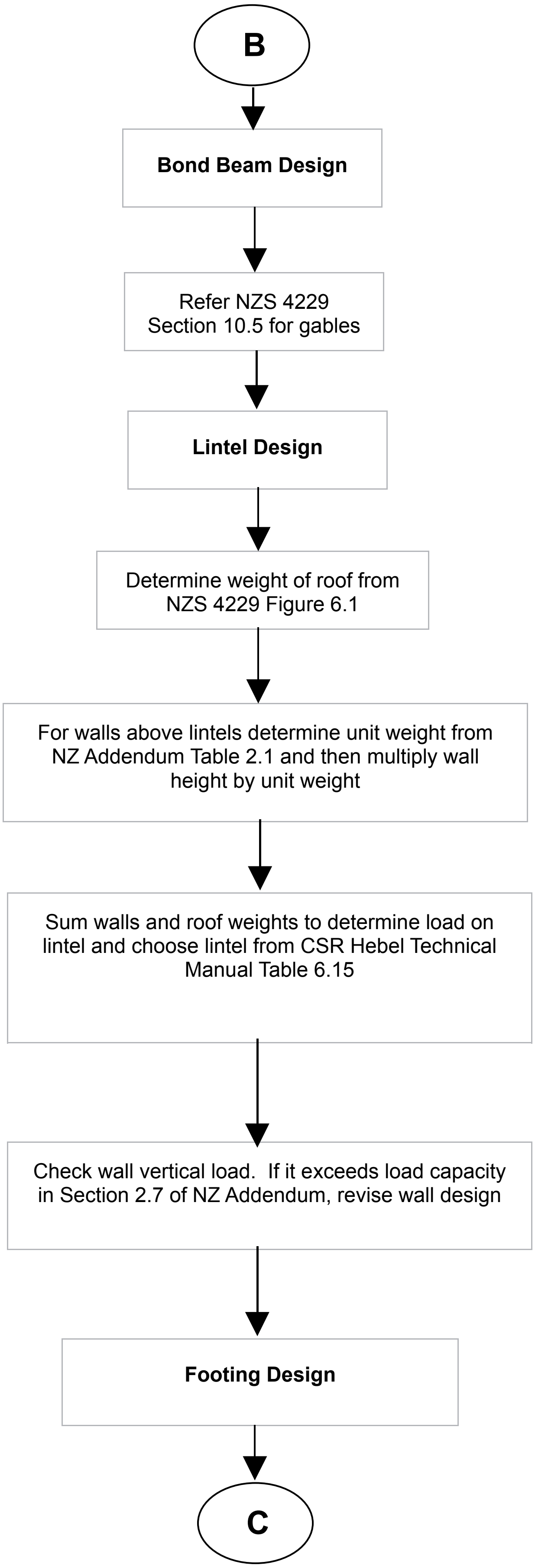
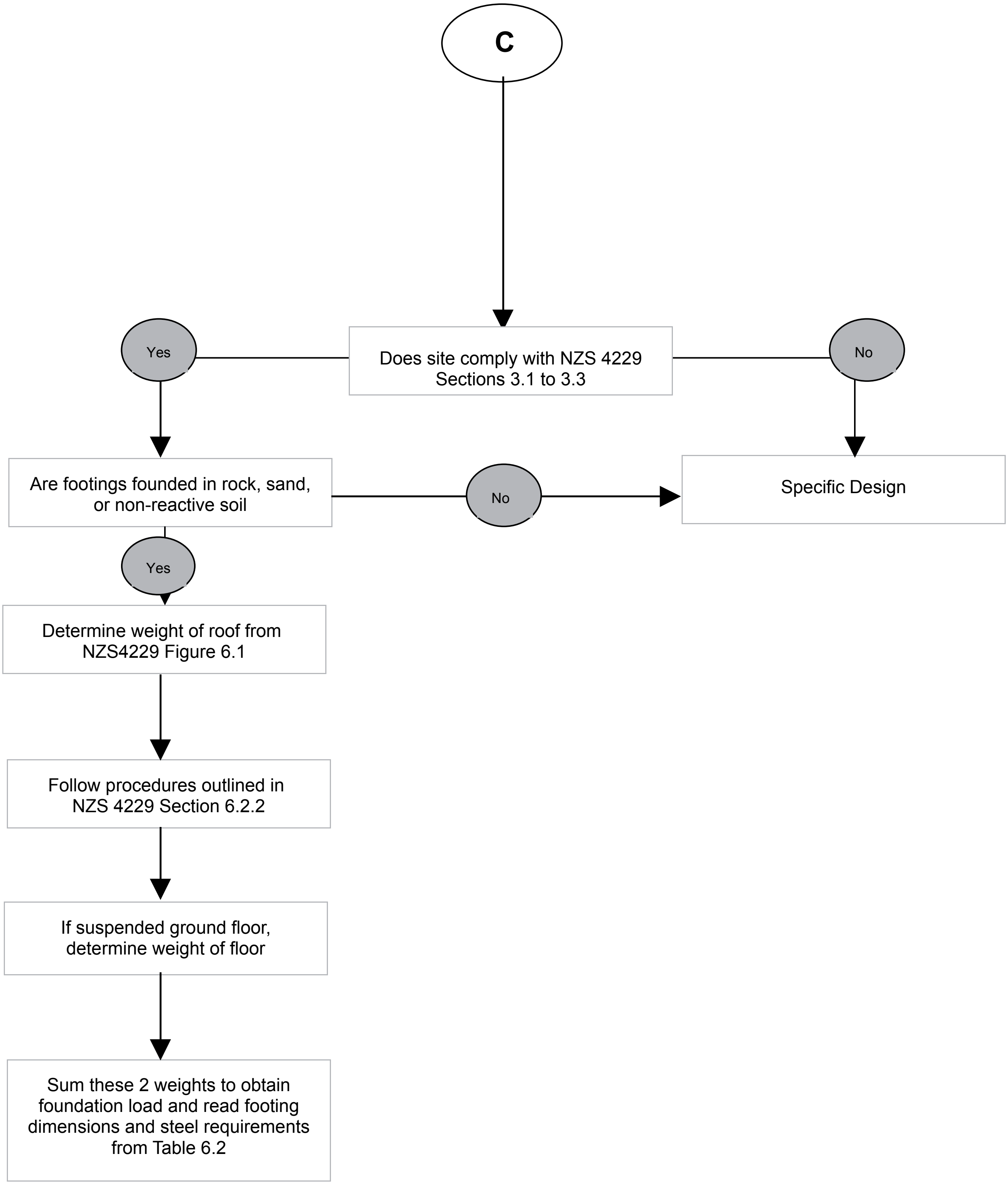

A
Will Diaphragm Action or Bracing Line Method be used?
Diaphragm Action
Bracing Line
Ceiling Diaphragm
Specific Engineering Design Required.
Ensure compliance with NZS 4229 Sections 9.1 and 9.2
Provide Bond Beams as per details noted in NZ Addendum Section 2.10
Detail connections as per NZS 4229, 9.2.4
Nominate bracing panels for all edges of diaphragm taking into account positions of movement joints.
Check NZS 4229, 8.8.1 through 8.8.4 and assign appropriate % of Total BU's of Bracing Demand for area covered by diaphragm to supporting walls.
Determine Bracing Capacity of each panel from NZ Addendum.
B


B
Bond Beam Design
Refer NZS 4229
Section 10.5 for gables
Lintel Design
Determine weight of roof from
NZS 4229 Figure 6.1
For walls above lintels determine unit weight from
NZ Addendum Table 2.1 and then multiply wall
height by unit weight
Sum walls and roof weights to determine load on
lintel and choose lintel from CSR Hebel Technical
Manual Table 6.15
Check wall vertical load. If it exceeds load capacity
in Section 2.7 of NZ Addendum, revise wall design
Footing Design
C


C
Does site comply with NZS 4229 Sections 3.1 to 3.3
Yes
No
Are footings founded in rock, sand, or non-reactive soil
No
Specific Design
Yes
Determine weight of roof from NZS4229 Figure 6.1
Follow procedures outlined in NZS 4229 Section 6.2.2
If suspended ground floor, determine weight of floor
Sum these 2 weights to obtain foundation load and read footing dimensions and steel requirements from Table 6.2

Section 6: HEALTH & SAFETY, PERFORMANCE & CERTIFICATION, GUARANTEE, AND DISCLAIMER

Health & Safety.

Information on any known health risks of our products and how to handle them safely is on their package and/or the documentation accompanying them.
Additional information is listed in the Material Safety Data Sheet (MSDS).
To obtain a copy of a MSDS, telephone LCNZ Ltd on 03 455 1502 or download from www.hebelaustralia.com.au > Products > Product Safety.
Contractors are required by law to perform their own risk assessments before undertaking work.
CSR Hebel has sample Safe Work Method Statements (SWMS) to assist in this.
To obtain a sample SWMS, refer also to the above sources.

Performance & Certification.

CSR Hebel is a business of CSR Building Products Limited A.B.N. 55 008 631 356. It is a manufacturer and supplier of CSR™ Hebel® Autoclaved Aerated Concrete (AAC) products. Because it is a manufacturer and supplier only, CSR Hebel does not employ people qualified as Accredited or Principal Certifiers. CSR Hebel is therefore unable to provide Construction Compliance Certificates or Statements of Compliance.
CSR Hebel conducts appropriate testing of its products and systems to determine performance levels. These include structural, fire and acoustic. Testing is conducted and certified by appropriate specialists in these fields. When using CSR™ Hebel® products and systems in specific projects, such specialists should be consulted to ensure compliance with the Building Code of Australia and relevant Australian Standards.

Guarantee.

CSR Hebel guarantees the products manufactured by itself and products used in the systems described in CSR Hebel literature, subject to the terms and conditions of the CSR Hebel Guarantee. Information on the terms and conditions of the CSR Hebel Guarantee can be obtained from your CSR Hebel supplier in New Zealand. CSR Hebel does not however guarantee the components, products or services, such as installation, supplied by others.

Disclaimer.