Concrete Masonry
Compliance with Clause H1 – Energy Efficiency

1.0 The New Zealand Building Code

The New Zealand Building Code (NZBC) Clause H1 has as its objective the efficient use of energy in buildings. The performance requirements as they relate to housing and amended on the 13 August 2007 are, **'Buildings must be constructed to ensure that their Building Performance index (BPI) does not exceed 1.55'**.

1.1 Compliance Documents

Designers can demonstrate compliance with these provisions by either following the Acceptable Solution (H1/AS1) or may verify compliance by means of the Verification Method (H1/VM1).

The compliance document called up as the Acceptable Solution H1/AS1 and the Verification method H1/VM1, is NZS 4218 **'Energy efficiency-housing and small building envelope'** as modified by the Acceptable Solution.

Reference can also be made to NZS 4214 **'Methods for determining the total thermal resistance of parts of a building'**.

2.0 Compliance Methods

NZS 4218 has several methods that can be followed to show compliance. These are:

- Schedule Method.
- Calculation Method.
- Modelling Methods.

2.1 Schedule Method

The schedule method is an Acceptable Solution for H1 and sets the minimum R-values required for roof, wall, floors and glazing. This Acceptable Solution can only be used where the area of glazing is less than 30% of the area of walls. NZS 4218 gives values for:

- Non-solid construction, typical timber or steel framing with inserted insulation, Table 1.
- Solid construction, Table 2.

These tables in NZS 4218 are modified by Clause H1 of the NZBC and require increased R-values. H1 includes tables for:

- Non-solid construction, Replacement Table 1.
- Solid timber construction, Replacement Table 2(a).
- Solid construction (excluding solid timber) Replacement Table 2(b).

Replacement Table 2(b) applies to concrete masonry construction. It gives more options and allows buildings of solid construction to have lower R-values than buildings of non-solid construction, recognising the benefits of the appropriate use of thermal mass.

The thermal mass must be used in conjunction with good passive design to increase comfort and reduce energy use. Use of the R-values in Table 2(b) requires that the thermal mass is accessible, i.e. inside the insulated building envelope. Suitable proprietary concrete masonry products which meet this requirement are available.

If additional bulk insulation material is required to achieve the R-values in the table, this insulation must be installed on the outside of the masonry walls.

Replacement Table 2(b):

Building thermal envelope component	Minimum R-values (m^2 °C/W)					
	Climate Zone 1		Climate Zone 2		Climate Zone 3	
	Option 1a	Option 1b	Option 2a	Option 2b	Option 3a	Option 3b
Roof	R 3.5	R 3.5	R 3.5	R 3.5	R 3.5	R 3.5
Wall	R 0.8	R 0.8	R 1.0	R 0.9	R 1.2	R 1.0
Floor	R 1.5	R 1.3	R 1.5	R 1.3	R 1.5	R 1.3
Glazing (vertical)	R 0.26	R 0.31	R 0.26	R 0.31	R 0.26	R 0.31
Glazing (skylights)	R 0.26	R 0.31	R 0.26	R 0.31	R 0.31	R 0.31

NOTE: R- values in table 2(b) will be introduced in three stages as follows:

31 October 2007:	Climate Zone 3
30 June 2008:	Climate Zone 2
30 September 2008:	Climate Zone 1

2.2 Calculation Method

The calculation method is an Acceptable Solution for H1 and can be used where:

- The area of glazing is greater than 30% of the wall area (but less than 50%), or
- Several construction types are combined within the building envelope, or
- A lesser R-value is to be used for one element (e.g. wall), compensated by an increased R-value for one or more of the remaining elements (e.g. floor and roof).

The calculation method compares the heat loss of an equivalent building using the schedule values with the proposed building and R-values. The heat loss of the proposed building cannot be less than the scheduled equivalent.

2.3 Modelling Method

The modelling method is a Verification method. The proposed building is modelled using computer modelling software (such as BRANZ Annual Loss Factor (ALF) tool or BSim Building Energy Programme) and the total energy use is calculated. The energy use must be less than the same building modelled using R-values given in the schedule method.

3.0 Masonry Solutions

3.1 Solid Masonry Construction

Solid masonry construction with accessible thermal mass (i.e. with external insulation or using proprietary products) can use the Schedule Method to demonstrate compliance with the New Zealand Building Code.

3.2 Strapped and Lined Construction

3.2.1 Strapping and Lining Alternative 1 – Internal Thermal Mass Walls

Thermal mass modelling undertaken by Ensys Limited (November 2007)[1] employing the BSim Building Energy Programme (Danish Building Research Institute) was used to verify the compliance of this alternative with Clause H1 of the New Zealand Building Code.

Where the design requires the masonry construction to be exposed on the exterior and the insides are strapped and lined much of the benefit of thermal mass can be lost.

It has been demonstrated that this loss can be compensated for by providing the equivalent thermal mass to the interior of the building. This can be achieved by ensuring that at least 40% of the internal partition walls are constructed in masonry provided that the thermal mass is accessible.

By providing the thermal mass by means of 40% masonry internal walls, the schedule R-values of Table 2(b) in NZBC H1 may be used.

[1] Strap-and-lined concrete masonry R-values for use as an alternative solution to Clause H1 of the New Zealand Building Code, Ensys Limited.

3.2.2 Strapping and Lining Alternative 2; Methods 1, 2 & 3 – Insulated Exterior Walls

Where the thermal mass is not accessible, strapped and lined construction can achieve compliance with H1 as outlined below using Table 1 as the reference for the Calculation Method when determining wall R values. Glazing can not be more than 30% of total wall area.

Where the insulation is provided to the interior of the external walls and the design does not use exposed masonry internal walls, the loss of thermal mass can be compensated for by increasing the R-value of the external walls in accordance with the Calculation Method.

By increasing the R-value of the external walls to R 1.5 and using the higher schedule values in Table 2(b) for roof, floor and glazing, the resulting building will have an energy efficiency at least equivalent to that achieved using the schedule values.

Three methods of strapping and lining can be used to achieve an R-value of 1.5.

- **Method 1**

  45 x 45 mm timber strapping with 42 mm of polyurethane sheet insulation and 10 mm plasterboard lining. The sheet insulation must be standard density 32 kg/m^3 poly-urethane (with a k value of 0.021 or lower). Using the calculation method verifies a wall R-value of 1.59 for this construction.

- **Method 2**

  65 x 45 mm timber strapping with 60 mm of 'S' Grade expanded polystyrene (with a minimum R-value of 1.6) and 10 mm plasterboard lining. Using the calculation method verifies a wall R-value of 1.52 for this construction.

- **Method 3**

  50 mm of 'S' Grade expanded polystyrene with a minimum R-value of 1.3 adhesive fixed to the masonry wall with 10 mm plasterboard lining. Using the calculation method verifies a wall R-value of 1.6 for this construction.

In all instances the roof must have a minimum R-value of 3.5.

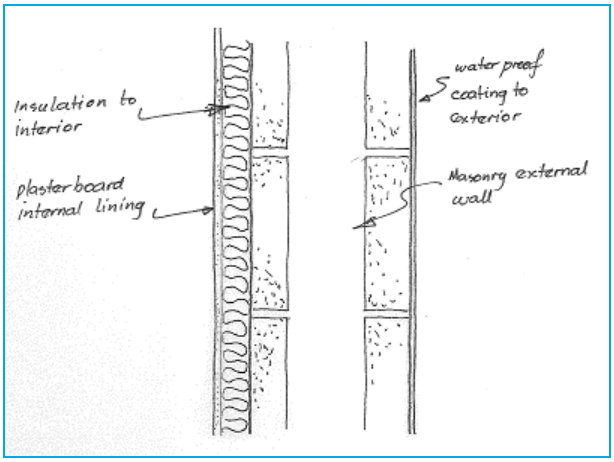

Figure 1: Typical Section - Insulated Exterior Walls (Strapping omitted for clarity)

Wall R Value Calculations for Strapped and Lined Walls:

Stage 1: Determine the R-value of the strapping and insulation: (Using Table E and equations 5 and 6 of NZS 4214:2006). 45 mm wide strapping at 600 ctrs vertically and 3 rows of 45 mm horizontal strapping.

Rs = Area timber/m^2 ÷ R timber	45 x 45 Strapping	0.339	65 x 45 Strapping	0.236	
Ri = Area insul/m^2 ÷ Rinsul	R2 Polyurethane	0.437	60 mm Polystyrene	0.582	
Total Rs + Ri	Total R per m^2	0.775	Total R per m^2	0.818	
R = 1 (sq m of wall) ÷ Total Rs+Ri	R Strapping and Insulation	***1.290***	R Strapping and Insulation	***1.223***	

Stage 2: Calculate Total Thermal Resistance - Wall

METHOD 1: Wall R Ratings 45 x 45 mm Strapping & Insulation		**METHOD 2: Wall R Ratings 65 x 45 mm Strapping & Insulation**		**METHOD 3: Wall R Ratings 50 mm Insulation**	
42 mm standard density 32kg/m^3 polyurethane sheet R= 2		60 mm R1.5 'S' Grade Polystyrene		50 mm R1.3 'S' Grade Polystyrene	
R_{se}	0.030	R_{se}	0.030	R_{se}	0.030
Block Masonry	0.140	Block Masonry	0.140	Block Masonry	0.140
Strapping and Insulation (from above)	***1.290***	Strapping and Insulation	***1.223***	Insulation	1.300
10 mm Plasterboard Lining	0.040	10 mm Plasterboard Lining	0.040	10 mm Plasterboard Lining	0.040
R_{si}	0.090	R_{si}	0.090	R_{si}	0.090
Rwall	**1.590**	**Rwall**	**1.523**	**Rwall**	**1.600**

APPENDIX 1

H1 R-value Verification Calculations for Strapped and Lined Concrete Masonry Walls

to NZS 4218:2004

MODEL HOUSE DATA

Area of Roof	=	165 m^2
Total Area of Walls Surfaces	=	147 m^2
Area of Wall	=	102.9 m^2
Glazing (30% Wall Area)	=	44.1 m^2
Area of Floor	=	165 m^2

Zone 1

Using Table 1 – Calculate Reference Heat Flow

HL ref	=	Aroof/Rroof	+	Awall/Rwall	+	Afloor/Rfloor	+	Aglazing/Rglazing
HL ref	=	165/2.9	+	102.9/1.9	+	165/1.3	+	44.1/0.26
HL ref	=	56.90	+	54.16	+	126.92	+	169.62
HL ref	=	407.59						

Heat Flow of Proposed Option must be ≤ to HLref

Proposed Strapping and Lining Option: Using Table 2(b) R-values for roofs and walls

HL prop		165/3.5	+	102.9/R_w	+	165/1.5	+	44.1/0.26
407.59	=	47.14	+	102.9/R_w	+	110.00	+	169.62
407.59 – 326.76	=	102.9/R_w						
80.83	=	102.9/R_w						
R_w	=	102.9/80.83						
R_w	**=**	**1.27**						

Provided R_w is higher than R1.27, HL proposed is less than HL ref = Compliant

Zone 3

Using Table 1 – Calculate Reference Heat Flow

HL ref	=	Aroof/Rroof	+	Awall/Rwall	+	Afloor/Rfloor	+	Aglazing/Rglazing
HL ref	=	165/3.3	+	102.9/2.0	+	165/1.3	+	44.1/0.26
HL ref	=	50.00	+	51.45	+	126.92	+	169.62
HL ref	=	397.99						

Heat Flow of Proposed Option must be ≤ to HLref

Proposed Strapping and Lining Option: Using Table 2(b) R-values for roofs and walls

HL prop		165/3.5	+	102.9/R_w	+	165/1.5	+	44.1/0.26
397.99	=	47.14	+	102.9/R_w	+	110.00	+	169.62
407.59 – 326.76	=	102.9/R_w						
71.23	=	102.9/R_w						
R_w	=	102.9/71.23						
R_w	**=**	**1.44**						

Provided R_w is higher than R1.44, HL proposed is less than HL ref = Compliant

Conclusion: By ensuring Rwall is 1.5 or greater; strapped, insulated and lined concrete masonry will comply with the insulation requirements of H1 for the model house.

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