Example energy efficiency calculation

NCC Volume Two Deemed-to-Satisy elemental provisions, climate zone 6

This case study provides an example of the calculations required to demonstrate compliance with the Part H6 Energy Efficiency Performance Requirements H6P1 and H6P2 using the Acceptable Construction Practice elemental provisions in H6D2(1)(b) and H6D2(2) of NCC 2022 Volume Two.

The example building is a timber-framed house located in Melbourne, Victoria. The case study shows how to calculate the requirements for the building fabric, external glazing and shading, ceiling fans and the net equivalent energy usage. Example calculations for building sealing and services are not included as no changes have been proposed to these provisions in NCC 2022.

Construction and site details

Table 1 Site and construction details (Plans in Attachment A)

Building Element	Detail
Building location	VIC
NCC climate zone	6
NCC building classification	Class 1 detached house with an attached Class 10a garage

Building Element	Detail
Roof & ceiling general arrangements	• Pitched with flat ceiling • Eaves with 500mm overhang • Timber framed • Tiled roof – colour – Monier "Ravine" – Solar Absorptance (SA) ≤ 1.0 • Downlights (to 0.5% of plan area of ceiling)
External wall general arrangements	• Timber-framed brick veneer with double brick subfloor walls • Brick colour – PGH Bricks & Pavers "Gledswood Blend" – SA ≤ 0.7 • Wall height – 2400mm
Floors and subfloor wall general arrangements	• Timber framed subfloor. • Subfloor wall height = 540mm • Floor area of building Class 1 part of building – approx. 160m^2
Main type of heater	Gas ducted 28kW output – 3.7 stars
Main type of cooler	No cooler
Type of water heater	Gas instantaneous
Installed capacity of rooftop photovoltaics	4.0kW
Swimming pool	No pool.
Spa	No spa.
Windows	Aluminium framed, double glazed – Low-e glass. Black powder coated – SA = 0.96

Calculations

Compliance Pathway: Compliance with the Performance Requirements is achieved as a Deemed-to-Satisfy Solution following the Acceptable Construction Practice set out in H6D2 Application of H6D2(1)(b).

Part 13.2 – Building fabric

1. Clause 13.2.1 - Building is Class 1 with an attached Class 10a garage, therefore clauses 13.2.2 to 13.2.6 and 13.2.7 apply.

2. Clause 13.2.2 – Where the following checks confirm that insulation is required, insulation shall comply with clause 13.2.2. This relates to material selection and construction/installation and is not described in detail here.

3. Clause 13.2.3 – For climate zone 6 roof minimum R-Values, sub-clause (1)(f) applies.
    a. Roof is pitched with flat ceiling, therefore Table 13.2.3g applies.
        i. SA for tiles is ≤ 1.0, therefore adopt 1.0 (based on product technical literature)
        ii. Roof is considered standard (no wind-driven or mechanical ventilators)
        iii. Adopting option with non-reflective under-roof insulation minimum roof insulation requirements are:
            A. R1.0 under roof insulation
            B. R3.5 ceiling insulation
                1. Note, roof ventilation is required in accordance with Note 3 of Table 13.2.3g.

4. Sub-clause 13.2.3(4) – Where ceiling insulation is reduced due to presence of downlights, this is compensated by increasing ceiling R-Value in accordance with Table 13.2.3s.
    a. Area of ceiling insulation is reduced by 0.5%, therefore, adjusted ceiling minimum R-Value = 4.0.

5. Roof is constructed from timber framing, therefore subclause 13.2.3(5) does not apply.

6. Note, although this is a metal sheet roof, sub-clause 13.2.3(6) does not apply as this roof has a flat ceiling lining which is not attached directly to the purlins, rafters or battens, regardless of whether any of the purlins, rafters or battens are metal.

7. Clause 13.2.4 does not apply as there are no roof lights in this building.

8. Clause 13.2.5 – walls are brick veneer construction, therefore sub-clause 13.2.5(1) applies (except for the external walls of the subfloor space below the suspended floor, which is addressed separately).
    a. For climate zone 6, minimum R-Values are in accordance with Table 13.2.5k or 13.2.5l applies.
    b. For brick veneer, Table 13.2.5k applies.
    c. Solar absorptance value for bricks is ≤ 0.7, therefore adopt 0.7 as design value.
    d. For 500mm roof overhang and 2400mm wall height, minimum required R-Value = 2.5.

9. Wall framing is timber, therefore thermal bridging sub-clause 13.2.5(4) and sub-clause 13.2.5(5) do not apply.

10. Clause 13.2.6 Floors and subfloor walls
    a. The floor is not over an unenclosed space, therefore sub-clause 13.2.6(1) does not apply.
    b. In accordance with sub-clause 13.2.6(2)(f), subfloor insulation in accordance with Table 13.2.6f.
        i. Subfloor wall height – 540mm, therefore adopt height = 600mm from Table 13.2.6f adopt either:
            A. R2.0 suspended floor insulation, or
            B. R1.5 suspended floor insulation and reflective foil insulation facing down over the subfloor space.
                1. Adopt R2.0 suspended floor insulation in this case.
    c. Note sub-clause 13.2.6(3)-(6) do not apply as subfloor is a timber framed suspended floor.

11. Clause 13.2.7 – The roof of the garage to the building does not share a common roof with the Class 1 part. Therefore, it is practical to design this as a separate part to the building. In this case the shared internal walls between the garage (Class 10a part) and Class 1 part require continuous insulation as detailed above for the external walls of the Class 1 part.

    Otherwise, the garage external fabric can be insulated as required, based on the construction details of its roof, walls, window and floor (example details of this have not been included and would require checking separately).

Part 13.3 – External glazing

1. Clause 13.3.2 External Glazing – Winter:
    a. In accordance with sub-clause 13.3.2(1), the allowable ratio of glazing conduction and solar heat gain of the glazing in the storey is given in Table 13.3.2a and is:
        i. C_u/C_{SHGC} = 6.06 (for suspended floor in climate zone 6)
    b. The design value of C_u/C_{SHGC} is calculated in accordance with sub-clause 13.3.2(1)(b) as follows:
        i. $[(A_1 \times U_1 \times BC_1 \times OC_1 \times R_1) + (A_2 \times U_2 \times BC_2 \times OC_2 \times R_2) + ...] / [(A_1 \times SHGC_1 \times EW_1 \times BSW_1 \times LW_1 \times FW_1 \times HW_1 \times R_1) + (A_2 \times SHGC_2 \times EW_2 \times BSW_2 \times LW_2 \times FW_2 \times HW_2 \times R_2) + ...]$.
            A. The table below sets out the values used in the expression above.
    c. From the table below, the ratio of glazing conduction (C_u) and solar gain (C_{SHGC}) = 5.59. This is less than the allowance given in sub-clause 13.3.2(1), therefore is acceptable.

Figure 1 Table of input variables for the calculation of the ratio of glazing conduction and solar heat gain (Cu/CSHGC) – winter 2.3

ROOM	GLAZING ELEMENT	Height	Width	A	U	SHGC	P/H	E_W	BC	OC	R	BS_W	L_W	F_W	H_W	C_u	C_{SHGC}
NOTES	Orientation as per building plan	As per building elevations	As per building elevations	Area of window units (m^2)	As per AFRC Technical Protocols and Procedures Manual	As per AFRC Technical Protocols and Procedures Manual	Refer Table 13.3.2m. Note, P/H has been conservatively rounded up to the next higher value noted in the table (values may be interpolated for more accurate results).		Refer Table 13.3.2r	Refer Table 13.3.2x	Refer Table 13.3.2af	Refer Table 13.3.2af	Refer Table 13.3.2af	Refer Table 13.3.2af	Refer Table 13.3.2af	A x U x BC x OC x R	A x SHGC x E_W x BS_W x L_W x F_W x H_W x R
Formal Lounge	Window 1 – East facing	2110	2600	5.486	2.70	0.52	500mm / 2110mm = 0.24	0.77	1.00	0.80	1.00	1.00	1.00	1.00	1.00	11.85	2.20
	Window 2 – South facing	2110	900	1.899	2.80	0.53	500mm / 2110mm = 0.24	0.3	1.00	0.80	1.00	1.00	1.00	1.00	1.00	4.25	0.30
	Window 3 – South facing	2110	900	1.899	2.80	0.53	500mm / 2110 = 0.24	0.3	1.00	0.80	1.00	1.00	1.00	1.00	1.00	4.25	0.30
Entry	Note applicable – timber front door with small glass panels, therefore exempt from this check															0.00	0.00
Kitchen	Window 4 – North facing	950	1550	1.473	2.80	0.53	500mm / 950mm = 0.53	1.04	1.00	1.00	1.00	1.00	1.00	1.00	1.00	4.12	0.81
Dining	Window 5 – North facing	2110	2350	4.959	2.60	0.52	500mm / 2110mm = 0.24	1.22	1.00	1.00	1.00	1.00	1.00	1.00	1.00	12.89	3.15
Family	Window 6 – North facing	2110	2350	4.959	2.70	0.51	500mm / 2110mm = 0.24	1.22	1.00	1.00	1.00	1.00	1.00	1.00	1.00	13.39	3.09
Master Bed	Window 7 – South facing	1200	1750	2.100	2.80	0.53	500mm / 1200mm = 0.42	0.26	1.10	0.80	1.00	1.35	1.00	1.00	1.00	5.17	0.39
Ensuite	Window 8 – South facing	900	600	0.540	3.30	0.54	500mm / 900mm = 0.56	0.26	1.00	0.80	1.00	1.00	1.00	1.00	1.00	1.43	0.08
Walk in Robe	Not applicable – No windows in this room															0.00	0.00
Bed 2	Window 9 – West facing	2110	1750	3.693	2.60	0.52	500mm / 2110mm = 0.24	0.75	1.10	0.80	1.00	1.35	1.00	1.00	1.00	8.45	1.94
Bathroom	Window 10 – West facing	1015	1200	1.218	3.30	0.54	500mm / 1015mm = 0.49	0.65	1.00	0.80	1.00	1.00	1.00	1.00	1.00	3.22	0.43
Bed 3	Window 11 – West facing	2110	1550	3.271	2.60	0.52	500mm / 2110mm = 0.24	0.75	1.10	0.80	1.00	1.35	1.00	1.00	1.00	7.48	1.72
Laundry	Window 12 - West facing	2110	1220	2.574	3.30	0.54	3024mm / 2110mm = 1.43	0.35	1.00	0.80	1.00	1.00	1.00	1.00	1.00	6.80	0.49
Garage	Not applicable – This is an unconditioned Class 10a building															0.00	0.00
															Total	83.30	14.89
															C_u/C_{SHGC}	5.59	

2. Clause 13.3.3 External Glazing – Summer:
    a. In accordance with sub-clause 13.3.3(1), the allowable aggregate solar heat gain of the glazing is calculated as follows:
        i. Floor area of storey x C_{SHGC} = 160 x 0.0980 = 15.680
            A. where C_{SHGC} = 0.0980 for suspended floor in climate zone 6 (obtained from Table 13.3.3a)
                1. Ventilation opening area is 12.639m^2 / 160m^2 x 100 = 7.9%. Values in Table 13.3.3a have been interpolated, for 7.9% Ventilation opening area.
    b. The design value of aggregate solar heat gain of the glazing is calculated in accordance with sub-clause 13.3.3(1)(b) as follows:
        i. (A_1 x $SHGC_1$ x E_{S1} x R_{s1} x L_{s1} x F_{s1} x H_{s1}) + (A_2 x $SHGC_2$x E_{S2} x R_{s2} x L_{s2} x F_{s2} x H_{s2}) + ...
            A. The table below sets out the values used in the expression above.
    c. From the table below, the aggregate solar heat gain = 11.86. This is less than the allowance given in sub-clause 13.3.3(1), therefore is acceptable.

Figure 2 Table of input variables for the calculation of the aggregate solar heat gain – summer

ROOM	GLAZING ELEMENT	Height	Width	A	Area of Ventilation Opening	U	SHGC	P/H	E_s	R_s	L_s	F_s	H_s	Aggregate Solar Heat Gain
NOTES	Orientation as per building plan	As per building elevations	As per building elevations	Area of window units (m^2)	Area of openable windows (m^2)	As per AFRC Technical Protocols and Procedures Manual	As per AFRC Technical Protocols and Procedures Manual	Refer Table 13.3.3o. Note, P/H has been rounded down to the next lower value noted in the table (values may be interpolated for more accurate results).		Refer Table 13.3.3x	Refer Table 13.3.3x	Refer Table 13.3.3x	Refer Table 13.3.3x	$A \times SHGC \times E_s \times Rs \times Ls \times Fs \times Hs$
Formal Lounge	Window 1 – East facing	2110	2600	5.486	1.920	2.70	0.52	500mm / 2110mm = 0.24	0.79	1.00	1.00	1.00	1.00	2.25
	Window 2 – South facing	2110	900	1.899	0.950	2.80	0.53	500mm / 2110mm = 0.24	0.18	1.00	1.00	1.00	1.00	0.18
	Window 3 – South facing	2110	900	1.899	0.950	2.80	0.53	500mm / 2110 = 0.24	0.18	1.00	1.00	1.00	1.00	0.18
Entry	Nota applicable – timber front door with small glass panels, therefore exempt from this check													0.00
Kitchen	Window 4 – North facing	950	1550	1.473	0.663	2.80	0.53	500mm / 950mm = 0.53	0.38	1.00	1.00	1.00	1.00	0.30
Dining	Window 5 – North facing	2110	2350	4.959	1.488	2.60	0.52	500mm / 2110mm = 0.24	0.55	1.00	1.00	1.00	1.00	1.42
Family	Window 6 – North facing	2110	2350	4.959	2.232	2.70	0.51	500mm / 2110mm = 0.24	0.55	1.00	1.00	1.00	1.00	1.39
Master Bed	Window 7 – South facing	1200	1750	2.100	0.945	2.80	0.53	500mm / 1200mm = 0.42	0.14	0.80	1.00	1.00	1.00	0.12
Ensuite	Window 8 – South facing	900	600	0.540	0.459	3.30	0.54	500mm / 900mm = 0.56	0.14	0.80	1.00	1.00	1.00	0.03
Walk in Robe	Not applicable – No windows in this room													0.00
Bed 2	Window 9 – West facing	2110	1750	3.693	0.923	2.60	0.52	500mm / 2110mm = 0.24	1.6	0.80	1.00	1.00	1.00	2.46
Bathroom	Window 10 – West facing	1015	1200	1.218	1.035	3.30	0.54	500mm / 1015mm = 0.49	1.29	0.80	1.00	1.00	1.00	0.68
Bed 3	Window 11 – West facing	2110	1550	3.271	0.818	2.60	0.52	500mm / 2110mm = 0.24	1.6	0.80	1.00	1.00	1.00	2.18
Laundry	Window 12 - West facing	2110	1220	2.574	0.257	3.30	0.54	3024mm / 2110mm = 1.43	0.6	0.80	1.00	1.00	1.00	0.67
Garage	Not applicable – This is an unconditioned Class 10a building													
				Total Area of Ventilation Opening	12.639								Total Aggregate Solar Heat Gain	11.86

Part 13.4 – Building sealing

Example calculations are not included for building sealing as there are no changes proposed for NCC 2022.

Part 13.5 – Ceiling fans

In accordance with clause 13.5.4, ceiling fans are not required as this building is in climate zone 6.

Part 13.6 – Whole-of-home energy usage

In accordance with clause 13.6.1 this part applies to the Class 1 building only as the Class 10a garage is not a conditioned space.

Clause 13.6.2 – Net equivalent energy usage

1. The net equivalent energy usage is calculated in accordance with clause 13.6.2(1)(a) as follows:
    a. $(A \times E_e) + E_P + E_S - E_R$, where
        i. $A = 160 \times 0.0097 = 1.552$
        ii. $E_e = 3.746$ (from Table 6.1.2 in ABCB Standard : Whole-of-home efficiency factors)
        iii. $E_P = E_S = 0$ (there is no pool or spa at this dwelling)
        iv. $E_R = 4.0$ (4.0kW photovoltaic panels installed on roof)
    b. Therefore, equivalent energy usage = $(1.552 \times 3.746) + 0 + 0 - 4.0 = 1.81$
2. The allowable net equivalent energy usage is calculated in accordance with 3.12.5.1(a)(ii) as follows:
    a. $A \times E_F$, where
        i. $E_F = 1.63$ (from Table 13.6.2b)
    b. Therefore, allowable net equivalent energy usage = $1.552 \times 1.63 = 2.53$
3. The net equivalent energy usage does not exceed the allowance, therefore meets the requirements of clause 13.6.2.

Part 13.7 – Services

Example calculations are not included for building services as there are no proposed changes for NCC 2022.

Summary of design requirements

Table 2 Summary of design requirements

Building element	Minimum requirements	Notes
Roof	R1.0 under roof insulation and R4.0 ceiling insulation (no requirement for reflective foil sarking).	Roof ventilation is required in accordance with Note 3 of Table 13.2.3g.
Walls	R2.5 wall insulation	
Floors and subfloor walls.	R2.0 insulation to suspended floor.	No subfloor wall insulation is required.
Glazing	Glazing Total System U-Value and Total System SHGC are as per values included in the tables above.	This example is based on nominal performance values of commonly available glazing systems using the WERS database as a reference point. Alternative glazing types may be adopted provided the ratio of C_u and C_{SHGC} meet the requirements of 13.3.1. This allows flexibility in window selection with the ability to offset some poorer performing systems with other higher performing systems within the same storey.
Building Sealing	In accordance with NCC Volume Two Part 13.4.	No changes to technical content of the building sealing provisions from NCC 2019 amdt 1, hence example calculations are not included.
Ceiling Fans	No requirement	There is no minimum requirement for ceiling fans in climate zone 6.

Building element	Minimum requirements	Notes
Class 10a part (garage)	Shared internal walls to be insulated in accordance with the requirements for walls above. No insulation requirements to external fabric (external walls, roof, slab).	As the garage is separated from the Class 1 part by construction having the required level of thermal performance, no insulation requirements apply.

Notes:

1. Compliance with other NCC provisions (such as fire, waterproofing, condensation, etc.) is not considered. This shall be considered separately when determining required construction arrangements and details.
2. These requirements are considered general in nature. Specific detailing requirements as required by NCC, relevant codes and standards and supplier product technical requirements are not included (such as fit-up and installation detailing, abutting and fixing of insulation, etc.). This shall be considered during design and construction.

Attachments

Design plans

The plans and specifications for this indicative house design used in this case study have been kindly provided by the Housing Industry Association (HIA) to assist with the consultation process on the draft NCC 2022 changes.

Figure 3 HIA house suspended floor - Elevations

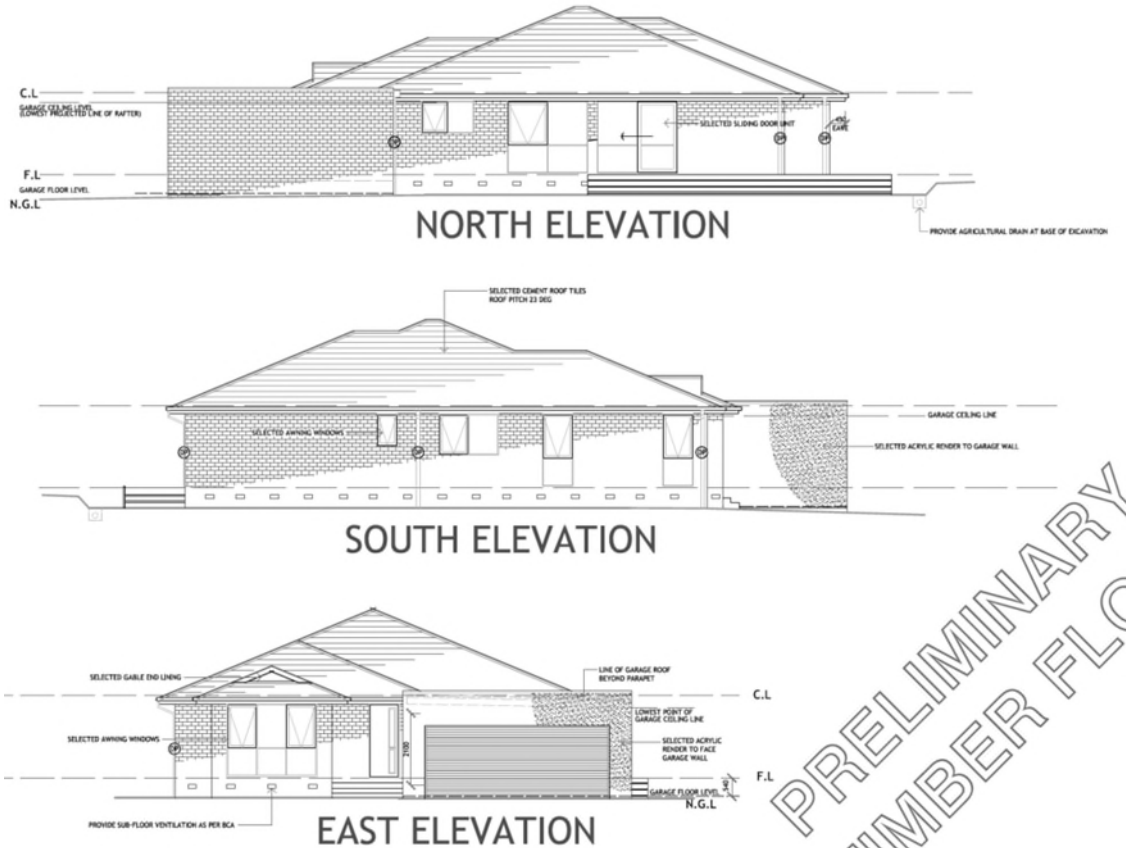


Figure 4 HIA house suspended floor - floor plan

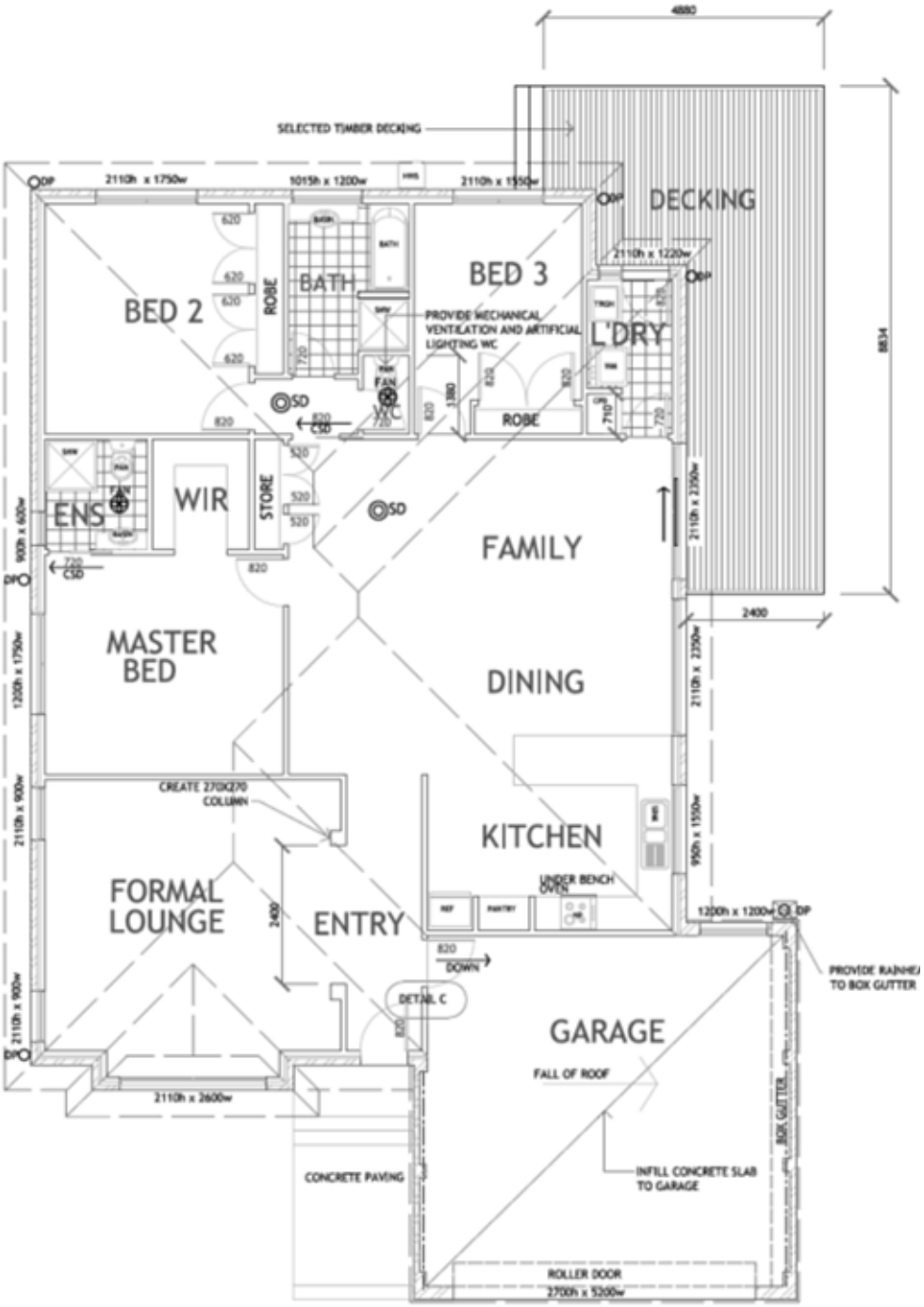
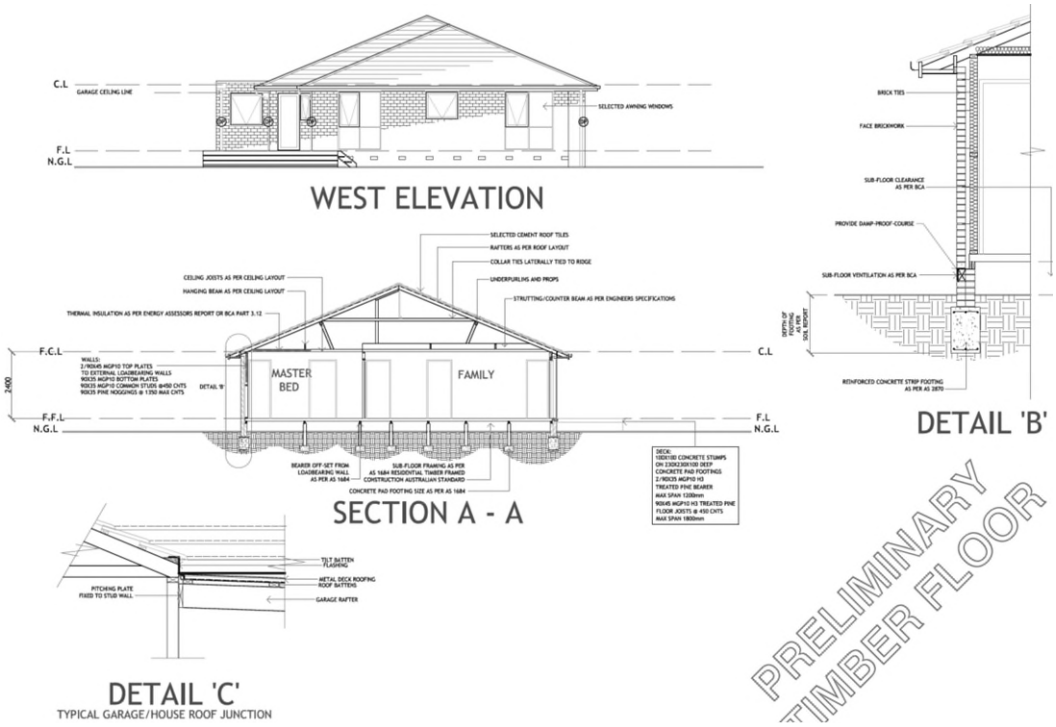
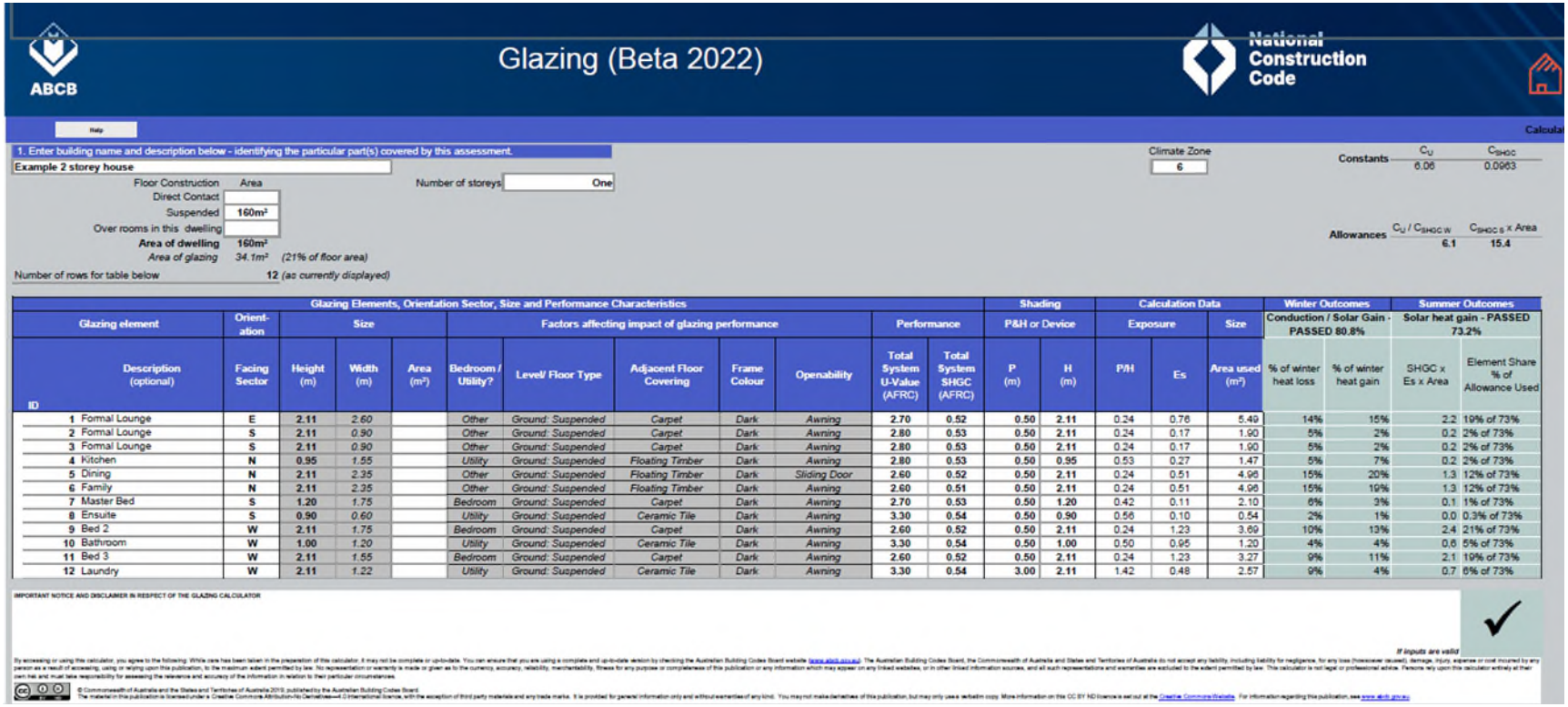


Figure 5 HIA house suspended floor – details



NCC 2022 Glazing Calculator (Beta)



Glazing (Beta 2022)

National Construction Code

1. Enter building name and description below - identifying the particular part(s) covered by this assessment.

Example 2 storey house

Climate Zone: 6

Constants: C_U 6.06, C_{SHGC} 0.0963

Allowances: C_U / $C_{SHGC\ W}$ 6.1, $C_{SHGC\ S}$ x Area 15.4

Floor Construction — Area
Direct Contact
Suspended 160m²
Over rooms in this dwelling
Area of dwelling 160m²
Area of glazing 34.1m² (21% of floor area)

Number of storeys: One

Number of rows for table below: 12 (as currently displayed)

Glazing Elements, Orientation Sector, Size and Performance Characteristics												Shading		Calculation Data			Winter Outcomes		Summer Outcomes	
Glazing element	Orient-ation	Size			Factors affecting impact of glazing performance					Performance		P&H or Device		Exposure		Size	Conduction / Solar Gain - PASSED 80.8%		Solar heat gain - PASSED 73.2%	
ID Description (optional)	Facing Sector	Height (m)	Width (m)	Area (m²)	Bedroom / Utility?	Level/ Floor Type	Adjacent Floor Covering	Frame Colour	Openability	Total System U-Value (AFRC)	Total System SHGC (AFRC)	P (m)	H (m)	P/H	Es	Area used (m²)	% of winter heat loss	% of winter heat gain	SHGC x Es x Area	Element Share % of Allowance Used
1 Formal Lounge	E	2.11	2.60		Other	Ground: Suspended	Carpet	Dark	Awning	2.70	0.52	0.50	2.11	0.24	0.76	5.49	14%	15%	2.2	19% of 73%
2 Formal Lounge	S	2.11	0.90		Other	Ground: Suspended	Carpet	Dark	Awning	2.80	0.53	0.50	2.11	0.24	0.17	1.90	5%	2%	0.2	2% of 73%
3 Formal Lounge	S	2.11	0.90		Other	Ground: Suspended	Carpet	Dark	Awning	2.80	0.53	0.50	2.11	0.24	0.17	1.90	5%	2%	0.2	2% of 73%
4 Kitchen	N	0.95	1.55		Utility	Ground: Suspended	Floating Timber	Dark	Awning	2.80	0.53	0.50	0.95	0.53	0.27	1.47	5%	7%	0.2	2% of 73%
5 Dining	N	2.11	2.35		Other	Ground: Suspended	Floating Timber	Dark	Sliding Door	2.60	0.52	0.50	2.11	0.24	0.51	4.96	15%	20%	1.3	12% of 73%
6 Family	N	2.11	2.35		Other	Ground: Suspended	Floating Timber	Dark	Awning	2.60	0.51	0.50	2.11	0.24	0.51	4.96	15%	19%	1.3	12% of 73%
7 Master Bed	S	1.20	1.75		Bedroom	Ground: Suspended	Carpet	Dark	Awning	2.70	0.53	0.50	1.20	0.42	0.11	2.10	6%	3%	0.1	1% of 73%
8 Ensuite	S	0.90	0.60		Utility	Ground: Suspended	Ceramic Tile	Dark	Awning	3.30	0.54	0.50	0.90	0.56	0.10	0.54	2%	1%	0.0	0.3% of 73%
9 Bed 2	W	2.11	1.75		Bedroom	Ground: Suspended	Carpet	Dark	Awning	2.60	0.52	0.50	2.11	0.24	1.23	3.69	10%	13%	2.4	21% of 73%
10 Bathroom	W	1.00	1.20		Utility	Ground: Suspended	Ceramic Tile	Dark	Awning	3.30	0.54	0.50	1.00	0.50	0.95	1.20	4%	4%	0.6	5% of 73%
11 Bed 3	W	2.11	1.55		Bedroom	Ground: Suspended	Carpet	Dark	Awning	2.60	0.52	0.50	2.11	0.24	1.23	3.27	9%	11%	2.1	19% of 73%
12 Laundry	W	2.11	1.22		Utility	Ground: Suspended	Ceramic Tile	Dark	Awning	3.30	0.54	3.00	2.11	1.42	0.48	2.57	9%	4%	0.7	6% of 73%

IMPORTANT NOTICE AND DISCLAIMER IN RESPECT OF THE GLAZING CALCULATOR

If inputs are valid