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4 Requirements

4.1 site orientation

Site layouts should enable buildings to design in the direction in figures B.1 to B.6 (See Annex B) or approximately due north

4.2 building orientation

Buildings should be orientated in accordance with figures B.1 to B.6 (see annex B), or approximately true north. If buildings cannot be thus orientated, they shall be orientated to achieve the lowest net energy use. Orientation sectors are shown in figure 1.

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Requirements

Living spaces shall be arranged so that the rooms where people spend most of their hours are located on the northern side of the unit.

Uninhabited rooms such as bathrooms and storerooms can be used to screen unwanted western sun or to prevent heat loss on the south facing facades. Living rooms should ideally be placed on the northern side.

The longer axis of the dwelling shall be orientated so that it runs as near east/west as possible.

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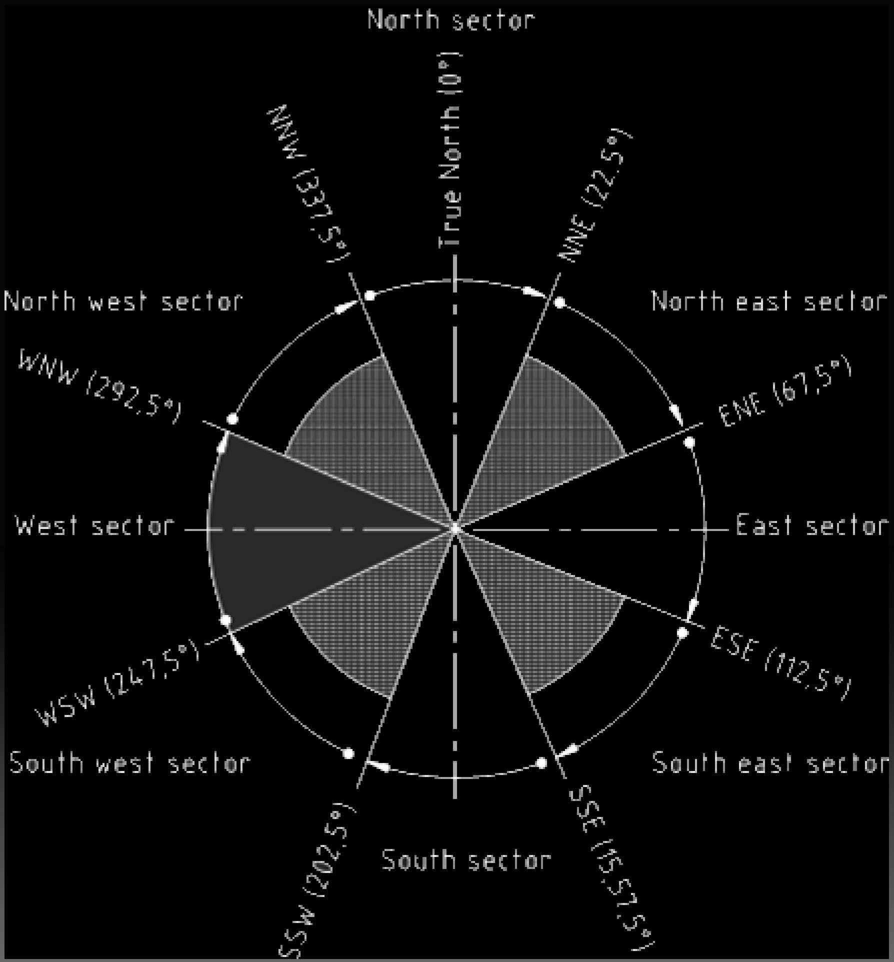
Energy Efficiency in buildings

Requirements

4.2 building orientation Figure 1 Orientation sectors



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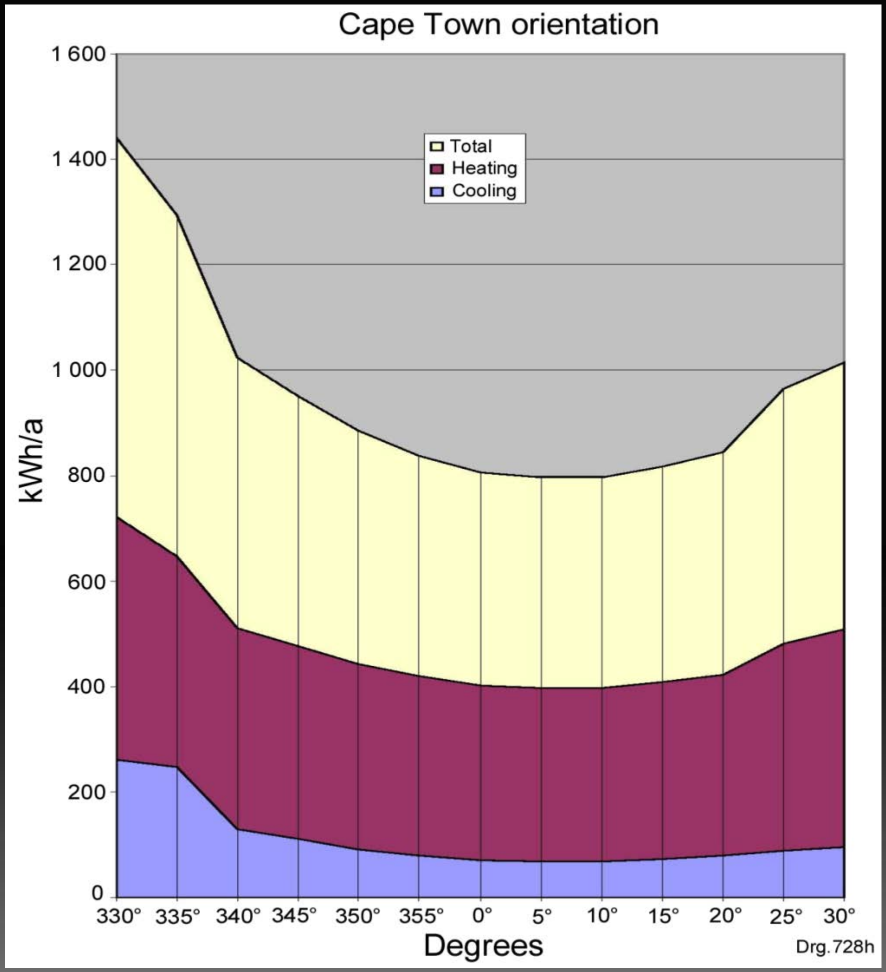
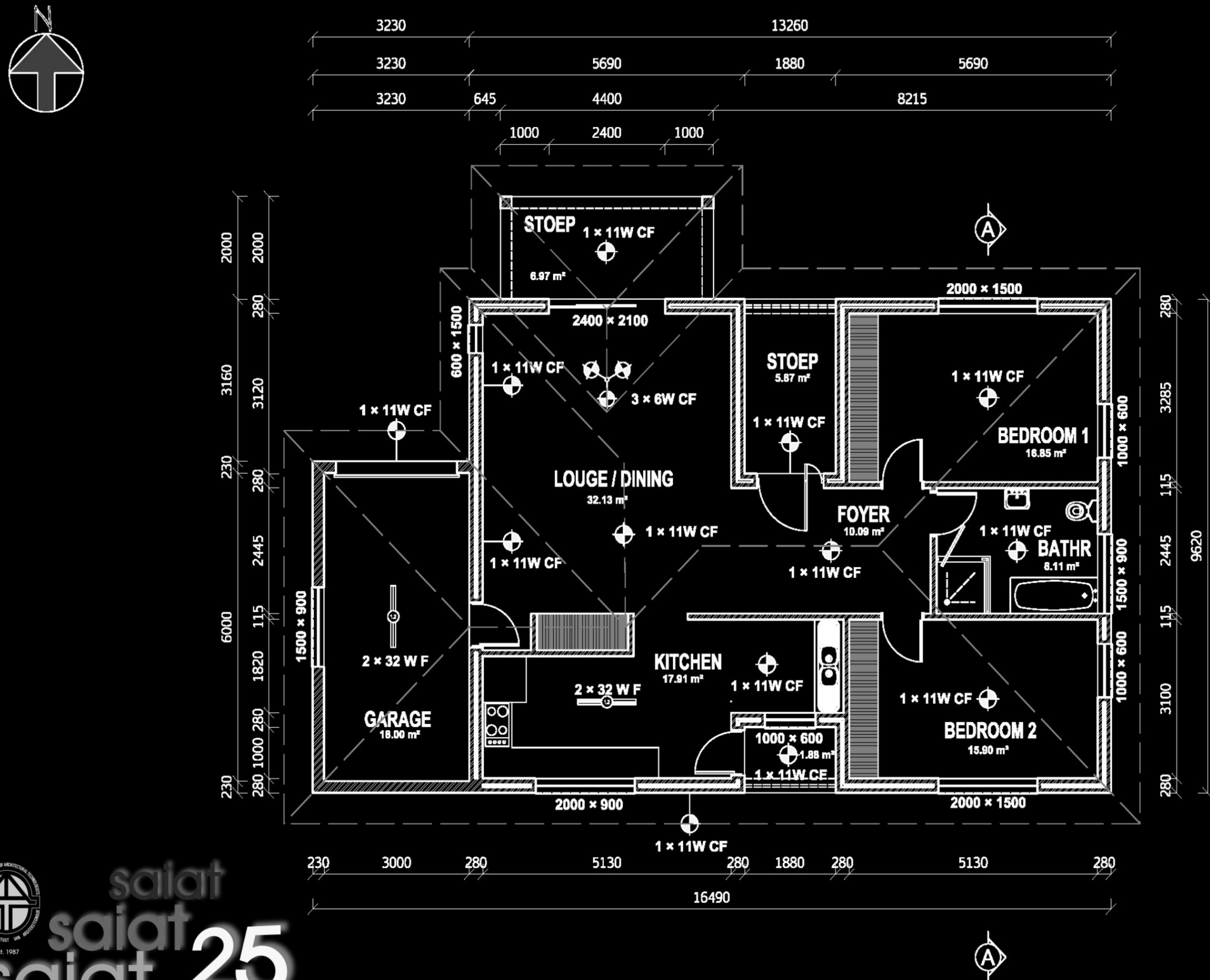
Annex B

Building Orientation

4.2 building orientation figs B.1 to B.6





N
STOEP
1 × 11W CF
6.97 m²
2400 × 2100
600 × 1500
1 × 11W CF
3 × 6W CF
LOUGE / DINING
32.13 m²
1 × 11W CF
1 × 11W CF
STOEP
5.87 m²
1 × 11W CF
FOYER
10.09 m²
1 × 11W CF
2000 × 1500
1 × 11W CF
BEDROOM 1
16.85 m²
1000 × 600
1 × 11W CF
BATHR
8.11 m²
1500 × 900
1000 × 600
1 × 11W CF
2 × 32 W F
GARAGE
18.00 m²
1500 × 900
KITCHEN
17.91 m²
2 × 32 W F
1 × 11W CF
1000 × 600
1.88 m²
1 × 11W CF
1 × 11W CF
BEDROOM 2
15.90 m²
2000 × 900
2000 × 1500
1 × 11W CF
A
A
3230
13260
3230
5690
1880
5690
3230
645
4400
8215
1000
2400
1000
2000
280
3160
230
6000
230
2000
280
3120
280
2445
115
1820
280
1000
280
280
3285
115
2445
115
3100
280
9620
230
3000
280
5130
280
1880
280
5130
280
16490


600
600
115
115
2100
2550
2270

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Energy Efficiency in buildings
Requirements

4.3 BUILDING DESIGN

4.3.1 general

Energy efficiency performance requirements of this standard will be satisfied by the

(a) applications of the provisions of 4.1 to 4.6 or

(b) by rational design that demonstrates equivalent to or better than the performance of a reference building using in 4.1 to 4.6 or

(c) compliance with tables 1 and 2.

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Requirements

Table 1 Maximum energy demand per building classification for each climatic zone

1	2	3	4	5	6	7	8
Classification of occupancy of building	Description of building	Maximum energy demand VA/m²					
		1	2	3	4	5	6
A1	Entertainment / Public Assembly	65	80	90	80	80	85
A2	Theatrical / Indoor sport	85	80	90	80	80	85
A3	Places of instruction	80	75	85	75	75	80
A4	Worship	80	75	85	75	75	80
F1	Large shops / Malls	90	85	95	85	85	90
G1	Offices	80	75	85	75	75	80
H1	Hotel	90	85	95	85	85	90

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a The maximum demand shall be based on the sum of 12 consecutive monthly maximum demand values per area divided by $12/m^2$ which refers to the net floor area.

b The climatic zones are given in annex A.

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Energy Efficiency in buildings
Requirements

Table 2 Maximum annual consumption per building classification for each climatic zone

1	2	3	4	5	6	7	8
Classification of occupancy of building	Description of building	Maximum energy consumption $kWh/m^2.a$					
		1	2	3	4	5	6
A1	Entertainment / Public Assembly	650	600	585	600	620	630
A2	Theatrical / Indoor sport	420	400	440	390	400	420
A3	Places of instruction	420	400	440	390	400	420
A4	Worship	120	115	125	110	115	120
F1	Large shops / Malls	240	245	260	240	260	255
G1	Offices	200	190	210	185	190	200
H1	Hotel	650	600	585	600	620	630

Table 4 (SANS10400 XA) - Design occupancy times

1	3
Classification of occupancy of buildings	Design occupancy times hours per day/days per week
A1 and A2	18/7
A3 and G1	12/5
A4	6/4
F1	12/7
H1	24/7

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Requirements

a The annual consumption per square metre shall be based on the sum of the monthly consumption of 12 consecutive months.

b Non-electrical consumption, such as fossil fuels, shall be accounted for on a non-renewable primary energy thermal equivalence basis by converting mega joules to kilowatt hours.

c The climatic zones are given in annex A.

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4.3 BUILDING DESIGN

4.3.2 Floors

4.3.2.1 With the exception of zone 5 (see annex A), buildings with a floor area of less than 500 m^2 with a concrete slab-on-ground shall have insulation installed around the vertical edge of its perimeter which shall

a) have an *R*-value of not less than 1,0,

b) resist water absorption in order to retain its thermal insulation properties, and

c) be continuous from the adjacent finished ground level

1) to a depth of not less than 300 mm, or

2) for the full depth of the vertical edge of the concrete slab-on-ground.

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Requirements

4.3.2 Floors

c) be continuous from the adjacent finished ground level

1) to a depth of not less than 300 mm, or

2) for the full depth of the vertical edge of the concrete slab-on-ground

4.3.2.2 Where an Underfloor (in-screed, under floor heating, underlaminate heating, undercarpet heating, undertile heating, cut-in under floor heating, waterbased under floor heating) heating system is installed, the heater shall be insulated underneath the slab with insulation that has a minimum *R*-value of not less then 1,0.

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Energy Efficiency in buildings

Requirements

4.3.2 Floors

4.3.2.3 With the exception of climatic zone 5, a suspended floor that is part of a building's envelope shall have insulation that shall retain its thermal properties under moist conditions and be installed

a) for climatic zones 1 and 2, with a partially or completely unenclosed exterior perimeter, and shall achieve a total *R*-value of 1,5,

b) for climatic zones 3, 4 and 6, with a partially or completely unenclosed exterior perimeter, and shall achieve a total *R*-value of 1,0, and

Requirements

4.3.2 Floors

c) with an in-slab in floor heating system, and shall be insulated around the vertical edge of its perimeter and underneath the slab with insulation having a minimum *R*-value of not less than 1,0.

NOTE Care should be taken to ensure that any required termite management system is not compromised by slab edge insulation. In particular the inspection distance should not be reduced or concealed behind the insulation.

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Requirements

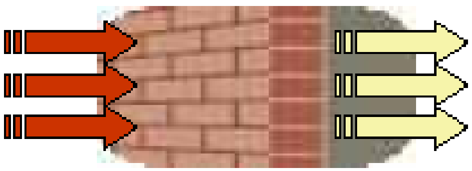
4.3 BUILDING DESIGN

4.3.3 External Walls

4.3.3.1 Masonry walls such as, but not limited to, cavity, grouted cavity, diaphragm, collar-jointed and single leaf masonry, shall achieve the minimum *CR*-value given in table 1 for the different types of occupancies in the different climatic zones (see climatic zones in annex A).

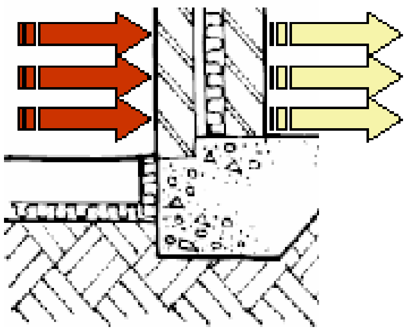
Walling and Energy Efficiency

Measuring the heat



K – value : W/m.K
(ability to conduct heat)
** 0 °C = 273 K*

Cavity brick



R – value : m^2K/W
(how well it resists heat conduction)

U – value : $W/m^2 \cdot K$
(how well it conducts heat)

MATERIAL	THERMAL MASS (volumetric heat capacity, $KJ/m^3.K$)
WATER	4186
CONCRETE	2060
SANDSTONE	1800
COMPRESSED EARTH BLOCKS	1740
RAMMED EARTH	1673
FC SHEET (COMPRESSED)	1530
BRICK	1360
EARTH WALL (ADOBE)	1300
AAC	550

Thermal Mass : $kJ/m^3.K$
(Heat energy storage ability)

also known as "Volumetric Heat Capacity"

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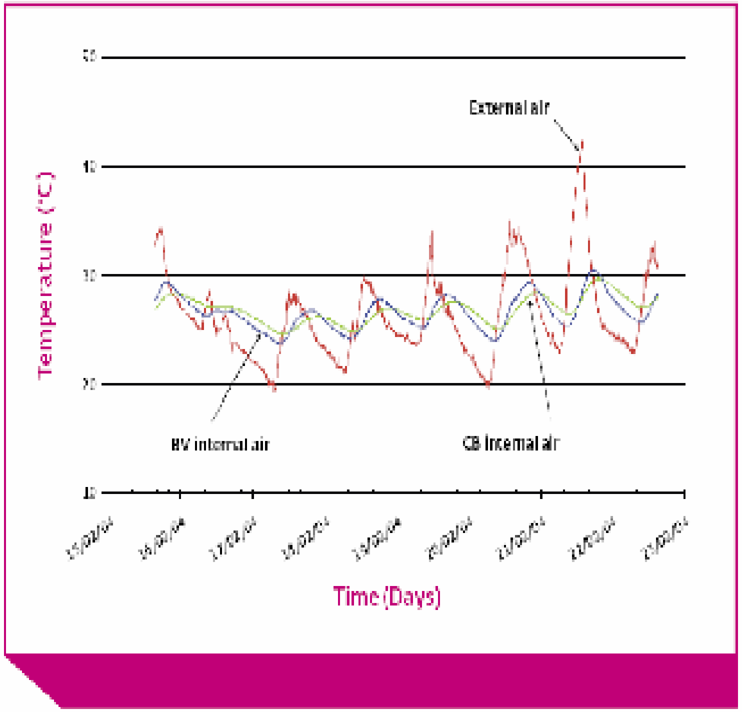
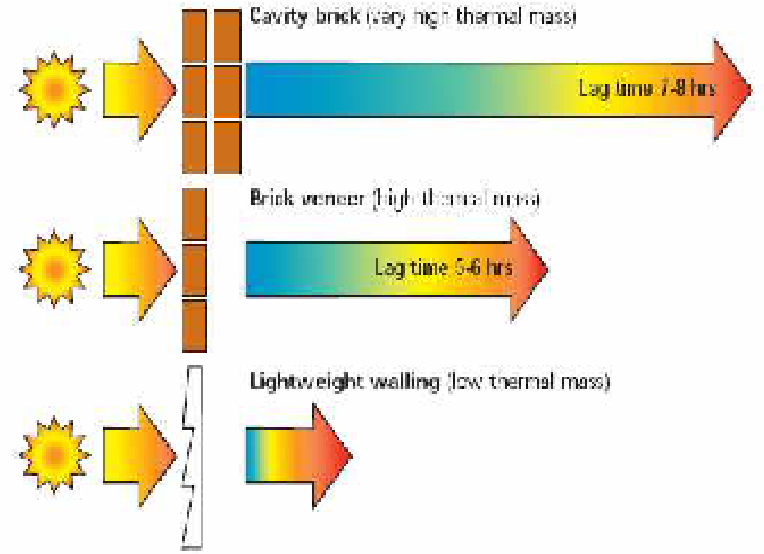
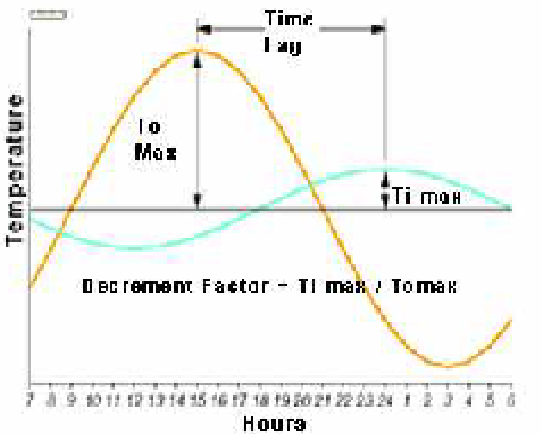
Walling and Energy Efficiency

Bring in the mass



Heat source and sink for radiative, convective and conductive heat exchange





Requirements

Table 3 - Minimum *CR*–value, in hours, for external walling

1	2	3	4	5	6	7
Occupancy Group	Climatic zone					
	1	**2**	**3**	**4**	**5**	**6**
	Number of hours					
Residential: E1 to E4, H1 to H5	100	80	80	100	60	90
Office and institutional: A1 to A4, C1 to C2, B1to B3, G1	80	80	100	100	80	80
F1-F3	80	80	120	80	60	100
Unclassified: A5, D1 to D4, J1 to J4	NR	NR	NR	NR	NR	NR

NOTE 1 NR = No requirement.

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4.3.3 External Walls

NOTE 1 Masonry walls refer to the external walls of the habitable portions of the building fabric only, therefore, there are no requirements for balustrade, foundation, free-standing, parapet and retaining walls.

NOTE 2 For the *CR*-values of walls, contact the relevant manufacturer/s. Refer to table 4 which provides typical values for double brick masonry walls, with or without additional insulation.

Requirements

Table 4 - Typical *CR*-values (hours)

Double Brick Wall Type	*CR*-value h
No cavity	40
With 50 mm air cavity	60
With $R = 0,5$ cavity insulation	90
With $R = 1$ cavity insulation	130

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Requirements

4.3.3 External Walls

NOTE 1 R=0,5 and R=1,0 refers to the thermal resistance of the insulation only, in m2K/W. Thermal resistance that is added to external walling with high thermal capacity, should be placed in between layers e.g. in the cavity of a masonry wall. Thermal resistance should not be added to the internal face of a wall with high thermal capacity.

NOTE 2 Wall systems that have low thermal capacity or resistance (or both) will not meet the requirements given in 4.4.3.1. See 4.3.3.8 for alternative requirements.

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4.3.3 External Walls

NOTE 3 Designers should consider that interstitial condensation occurs in walling systems which are not able to prevent or accommodate moisture migration. The selection of vapour barriers and appropriate construction materials, including insulation, is important for the thermal efficiency of walling in climate zones where damp and high relative humidity is experienced.

NOTE 4 Internal walls, in buildings with external walling as above, should ideally have *CR*-values of at least 20 hours. However, this is not a requirement for compliance.

NOTE 5 Refer to climatic zones in Annex A.

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Requirements

4.3.3 External Walls

4.3.3.2 External non-masonry walls shall

a) Achieve the *CR*-values in table 3 by the addition of capacity or resistance (or both),

b) Have the following minimum *R*-values (except A5, D1 to D4, J1 to J4 which have no minimum *R*-value requirements):

1) for climatic zones 1 and 6, a total *R*-value of 2,2; and

2) for climatic zones 2, 3, 4 and 5, a total *R*-value of 1,9; or

Requirements

4.3.3 External Walls

c) have *R*-values that comply with the requirements of ASTM C 177, ASTM C 518 and ASTM C 1363.

NOTE Internal walls in buildings with this type of external walling may be masonry or non-masonry.

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4.3.3 External Walls

4.3.3.3 Attached buildings such as garages, glasshouses, solariums or pool enclosures to the main building shall

a) have an external fabric that achieves the required level of thermal performance for that building, or

b) be separated from the main building with construction having the required level of thermal, performance for the building (see figure 2), or

c) not compromise the thermal performance of the main building.

Requirements

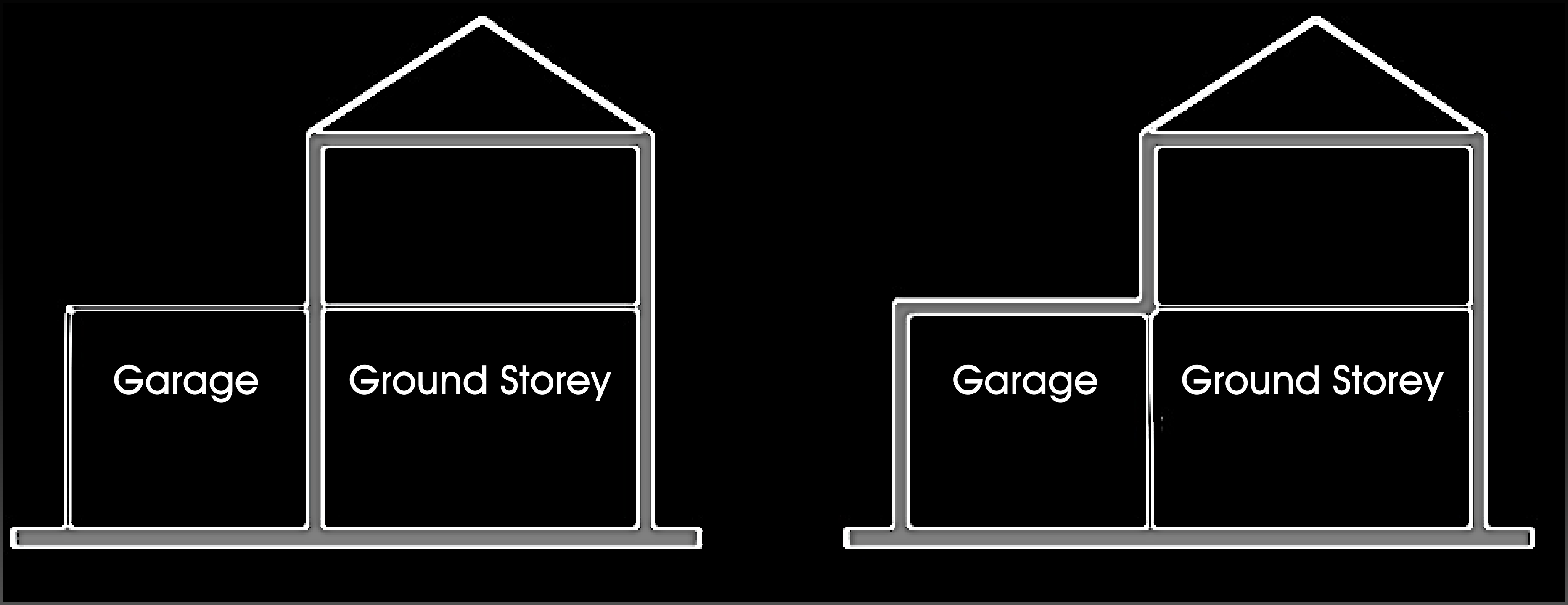
4.3.3 External Walls

4.3.3.4 In addition, an attached building can only be exempted from the regulations if it does not contain habitable spaces and is not provided with a heating/cooling installation, or if any heating/cooling installation is entirely fed from renewable energy sources.

NOTE 1 In Fig 2(a), the thermal performance required for the main building may be achieved by the outside walls and floor of the garage.

NOTE 2 In Fig 2.(b), the thermal performance required for the main building may be achieved by the walls and floor of the main building as if the garage were an under-floor space with an enclosed perimeter.

Requirements



Option (a) — Elevation

Option (b) — Elevation

Figure 2 — Separation of attachments

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4.3 BUILDING DESIGN

4.3.4 Fenestration

4.3.4.1 Fenestration for buildings with natural environmental control

4.3.4.1.1 The air leakage (AL) of external vertical glazing in each storey of a sole-occupancy unit, public space or other occupied space shall be assessed separately in accordance with 4.4.3.1.2 and 4.4.3.1.3.

4.3.4.1.2 The aggregate conductance and solar heat gain of the glazing in each storey shall not exceed the values obtained by multiplying the net floor area measured within the enclosing walls with the constants C_U for conductance and C_{SHGC} for solar heat gain given in table 5.

Requirements

Table 5 — Constants for conductance and solar heat gain

1	2	3	4	5	6	7
Constants	Climatic Zone					
	1	2	3	4	5	6
Conductance C_u	1,2	1,4	1,4	1,4	1,4	1,2
Solar Heat gain C_{SHGC}	0,15	0,12	0,10	0,13	0,11	0,13

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Requirements

4.3.4 Fenestration

4.3.4.1.3 The aggregate conductance and solar heat gain of the glazing in each storey shall be calculated by adding the conductance and solar heat gain of each glazing element to the following equations:

a) For conductance

$(A_1 \times U_1) + (A_2 \times U_2) + (A_3 \times U_3) + \ldots$

where

$A_{1,\,2,\,3}$ is the area of each glazing element (where 1, 2, 3, etc., refer to the specific glazing element);

$U_{1,\,2,\,3}$ is the *U*-value of each glazing element (where 1, 2, 3, etc., refer to the specific glazing element) (see table 6).

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b) For solar heat gain

$$(A_1 \times S_1 \times E_1) + (A_2 \times S_2 \times E_2) + (A_3 \times S_3 \times E_3)$$

where

$A_{1,\ 2,\ 3}$ is the area of each glazing element (where 1, 2, 3, etc., refer to the specific glazing element);

$S_{1,\ 2,\ 3}$ is the *SHGC* of the transparent or translucent element in each glazing element (where 1, 2, 3, etc., refer to the specific glazing area) (see table 6);

$E_{1,\ 2,\ 3}$ is the solar exposure factor for each glazing element obtained from the tables in annex C (where 1, 2, 3, etc., refer to the specific glazing element).

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4.3.4 Fenestration

4.3.4.1.4 The *U*-values and *SHGC* values in accordance with table 6 (worst-case glazing element performance), shall be used unless these values are supplied by the glazing manufacturers as verified according to the test method ASTM C 1199 and ISO 9050 for *U*-values, and given in NFRC 100 for *SHGC* values.

4.3.4.1.5 A building wall, including the glazing it contains, shall be considered to face north if it faces any direction in the north orientation sector of figure 1. The orientation of other walls, including the glazing they contain, shall be determined in a similar way.

Requirements

TABLE 6 Worst case whole glazing element performance values

1	2	3	4	5
Glass description	Performance values			
	Aluminium/Steel framing		Timber/PVCu/Aluminium Thermal Break framing	
	Total U-value	SHGC	Total U-value	SHGC
Single clear	7,90	0,81	5,60	0,77
Single tinted	7,90	0,69	5,60	0,65
Single Low E	5,73	0,66	4,06	0,63
Clear Double (3/6/3)	4,23	0,72	3,00	0,68
Tinted Double (3/6/3)	4,23	0,59	3,00	0.56
Clear Double Low E	3,40	0,66	2,41	0,62
Tinted Double Low E	3,40	0,54	2,41	0,51

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NOTE 1 By referring to "glazing elements requires *Total U*-values and *SHGCs* and is assessed for the combined effect of glass and frames. The measurements of these *Total U*-values and *SHGCs* are specified in the guidelines of the National Fenestration Rating Council (NFRC).

NOTE 2 *U*-value and *SHGCs,* based on the NFRC assessment methods are shown for some simple types of glazing elements in this table. (Smaller numbers indicate better glazing element performance.) The table gives worst case assessments, which can be improved by obtaining generic or custom product assessments from suppliers, manufacturers, industry associations (including their online resources) and from competent assessors.

NOTE 3 Low *E* assumes emissivity of 0,2, or better.

a Low E coating facing to the inside of the building

b Low *E* coating to surface 3 of the double glazed unit.

Requirements

4.3.4 Fenestration

4.3.4.2 Fenestration for buildings with centrally controlled artificial ventilation or air conditioning

4.3.4.2.1 The air leakage of external vertical glazing in each storey of a sole-occupancy unit, public space, or other occupied space, shall be assessed separately in accordance with 4.4.3.2.2 and 4.4.3.2.3.

4.3.4.2.2 The aggregate air-conditioning energy value attributable to the value must not exceed the allowance obtained by multiplying the façade area of the orientation by the energy index given in table 7

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TABLE 7 Energy index

1	2	3	4	5	6
Climatic Zone					
1	2	3	4	5	6
0,220	0,257	0,221	0,220	0,180	0,227

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Requirements

4.3.4 Fenestration

4.3.4.2 Fenestration for buildings with centrally controlled artificial ventilation or air conditioning

4.3.4.2.3 The aggregate air-conditioning energy value shall be calculated by adding the air-conditioning energy value through each value element in accordance with the following equation:

$$A_1\ [S_1\ (C_A \times S_{H1} + C_B \times S_{C1}) + C_C \times U_1] +$$

$$A_2\ [S_2\ (C_A \times S_{H2} + C_B \times S_{C2}) + C_C \times U_2] + \ldots$$

Requirements

4.3.4 Fenestration

Where

$A_{1,\,2,\,3}$ is the area of each glazing element (where 1, 2, 3, etc., refer to the specific glazing element);

$S_{1,\,2,\,3}$ is the *SHGC* of each glazing element given in table 6 (where 1, 2, 3, etc., refer to the specific glazing element);

$C_{A,\,B,\,C}$ are the energy constants given in table D.1 (see annex D);

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4.3.4 Fenestration

$S_{H1,\ H2,\ H2}$ is the heating shading multiplier element for each value element given in table D.2 (where H1, H2, H3, etc., indicate the specific heating shading multiplier element);

$S_{C1,\ C2,\ C3}$ is the cooling shading multiplier element for each glazing element given in table D.3 (where C1, C2, C3, etc., indicate the specific cooling shading multiplier element);

$U_{1,\ 2,\ 3}$ is the total *U*-value of each glazing element given in table 6 (where 1, 2, 3 etc., indicate the specific glazing element).

4.3.4.2.4 For the purposes of 4.3.4.2.3, where the air-conditioning energy value of a value element is calculated to be negative, the energy value shall be taken to be zero.

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4.3 BUILDING DESIGN

4.3.5 Shading

4.3.5.1 Where shading is used, the building shall

a) have a permanent feature such as a veranda, balcony, fixed canopy, eaves or shading hood, which

1) extends horizontally on both sides of the glazing for the same projection distance, *P* In figure 3, or

2) provides the equivalent shading with a reveal or other shading element (see figure 4),

Requirements

4.3.5 Shading

b) have an external shading device, such as a shutter, blind, vertical or horizontal building screen with blades, battens or slats, which

1) is capable of restricting at least 80 % of summer solar radiation, and
2) if adjustable, is readily operated either manually, mechanically or electronically by the building occupants.

4.3.5.2 For glazing where G exceeds 0,5 m, the value of *P* (see figure 3) shall be halved. (See annex E for an example of this calculation.)

Requirements

Figure 3 — Method of measuring *P* and *H*

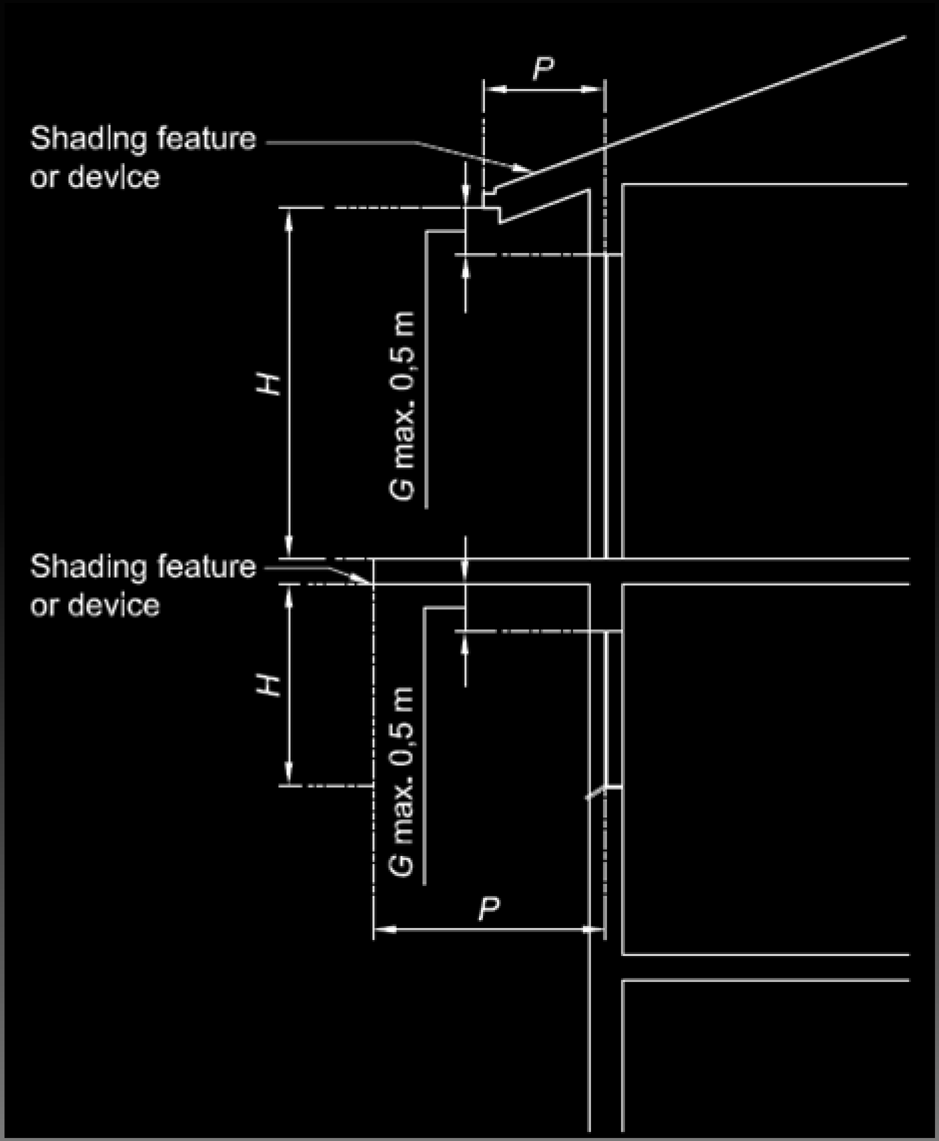
Key

P horizontal distance, expressed in metres, from the glass face to the shadow casting edge of any shading projection

H vertical distance from the base of the glazing element to the same shadow casting edge used to measure *P*

G vertical distance from the head of the glazing element to the shadow casting edge of any shading projection

NOTE An adjustable shading device that is capable of completely covering the glazing may be considered to achieve a *P*/*H* value of 2.



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4.3.6 Roof assemblies

4.3.6.1 General

4.3.6.1.1 A roof assembly shall achieve the minimum total *R*-value specified in table 8 for the direction of heat flow.

Requirements

Table 8 — Minimum total R-values of roof assemblies

1	2	3	4	5	6
Climatic zones					
1	2	3	4	5	6
Minimum required total R-value m². K/W					
3,7	3,2	2,7	3,7	2,7	3,5
Direction of heat flow					
Up	Up	Down and Up	Up	Down	Up

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4.3.6 Roof assemblies

4.3.6.1.2 A roof assembly that has metal sheet roofing fixed to metal purlins, metal rafters or metal battens shall have a thermal break consisting of a material with an *R*-value of not less than 0,2 installed between the metal sheet roofing and its supporting member.

See annex F for typical roof assembly construction and *R*-values of materials.

Requirements

4.3.6 Roof assemblies

4.3.6.2 Thermal insulation

4.3.6.2.1 Insulation shall comply with minimum required *R*-values and be installed so that it

a) abuts or overlaps adjoining insulation, or is sealed,

b) forms a continuous barrier with ceilings, walls, bulkheads or floors that contribute to the thermal barrier, and

c) does not affect the safe or effective operation of any services, installation, equipment or fittings.

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4.3.6 Roof assemblies

4.3.6.2.2 Thermal insulation material shall be either

a) non-combustible when tested in accordance with SANS 10177-5, and may be installed in all occupancy classes; or

b) classified as combustible in accordance with SANS 10177-5, and shall be tested and classified in accordance with SANS 428 for its use and application.

Table B.1 — Symbolic classification of non-combustible materials

1	2	3	4
Surface fire properties			**Classification**
Small-scale application[a]	**Large-scale application**[b]	**Behaviour of material**	
Flame spread from back wall or downstand mm			
≤ 2 000	≤ 4 000	No flame spread	A1
≤ 3 000	≤ 6 000	Low flame spread (no flaming droplets or burning brand)	A2
		Low flame spread (with flaming droplets or burning brand)	A3
≤ 4 000	≤ 8 000	Average flame spread (no flaming droplets or burning brand)	A4
		Average flame spread (with flaming droplets or burning brand)	A5
> 4 000	> 8 000	Rapid fire spread	A6

[a] When determined in accordance with SANS 10177-10.

[b] When determined in accordance with SANS 10177-11.

Table B.2 — Symbolic classification of combustible materials

1	2	3	4
Surface fire properties			Classification
Small-scale application[a]	Large-scale application[b]	Behaviour of material	
Flame height from fire source mm			
≤ 2 000	≤ 4 000	No flame spread	B1
≤ 3 000	≤ 6 000	Low flame spread (no flaming droplets or burning brand)	B2
		Low flame spread (with flaming droplets or burning brand)	B3
≤ 4 000	≤ 8 000	Average flame spread (no flaming droplets or burning brand)	B4
		Average flame spread (with flaming droplets or burning brand)	B5
> 4 000	> 8 000	Rapid fire spread	B6

[a] When determined in accordance with SANS 10177-10.

[b] When determined in accordance with SANS 10177-11.

Table B.3 — Limitations on the use of materials

1	2
Use identification	**Occupancy description (use or limitation)**
1	No limitation
2	All occupancies, except for the proviso listed in SANS 10400-T
3	All single-storey and double-storey buildings, except A1, C1, C2, E1, E2, E3, H1 and H2
4	All single-storey buildings, except A1, C1, C2, D1, E1, E2, E3, H1 and H2
5	All single-storey buildings, except A1, A2, A3, C1, C2, D1, E1, E2, E3, F1, F3, G1, H1, H2, J1 and J4
6	Not acceptable for any application

Table B.4 — Symbolic application identification of materials

1	2
Application identification	**Description of permissible application**
H	Horizontal (under-roof) only
V	Vertical (side cladding)
HV	Horizontal and vertical

TABLE 3
BULK INSULATION (RIGID FACED) REGISTER
INSTALLED AS NAIL UP OR SUSPENDED CEILING

Product Name	Type	Insulation Manufacturer / Sole Distributor	Fire Report Number	Report Date	Fire Classification
*ThermocousTex MetroBoard	Polyester/Vinyl	Frame Industrials	FTC09/049	04/07/2009	B/B1/2/H USP

TABLE 4
BULK INSULATION (RIGID UNFACED) REGISTER
GENERALLY INSTALLED UNDER ROOF & OVER PURLINS AND/OR SIDE CLADDING IN BUILDINGS
Note: Bulk rigid insulation is generally un-faced UNLESS SPECIFIED which then changes the product classification

Product Name	Type	Insulation Manufacturer / Sole Distributor	Fire Report Number	Report Date	Fire Classification
*Isoboard	XPS	Isofoam SA (Pty) Ltd	FTC05-051	30/11/2007	B/B1/2/HV (SP & USP)
*StyFRene	EPS	Automa Multi Styrene	FTC06-075	13/12/2006	B/B1/2/HV (SP & USP)
*StyFRene	EPS	Isolite	FTC06-075	13/12/2006	B/B1/2/HV (SP & USP)
*StyFRene	EPS	Sagex	FTC06-075	13/12/2006	B/B1/2/HV (SP & USP)
*StyFRene	EPS	Technopol	FTC06-075	13/12/2006	B/B1/2/HV (SP & USP)
*ThermocousTex Plain Board 25mm	Polyester Board	Frame Industrials	FTC07/149	05/12/2007	B/B1/2/H (SP & USP)
*ThermocousTex Plain Board 30mm	Polyester Board	Frame Industrials	FTC10/007	12/03/2010	B/B1/2/V (USP)
*ThermocousTex PlainBoard 120mm	Polyester Board	Frame Industrials	FTC08/049	01/12/2008	B/B1/2/H (USP)

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4.3.6 Roof assemblies

c) with each adjoining sheet of roll membrane being

1) overlapped by not less than 100 mm, or

2) taped together.

The *R*-value of reflective insulation is affected by the airspace between a reflective side of the reflective insulation and the building lining or cladding. Dust build-up reduces *R*-values. Table 9 gives typical *R*-values for reflective insulation in specific circumstances.

NOTE See table 10 regarding typical *R*-values for roof/ceiling construction and the resulting typical intervention insulation thicknesses.

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4.3.6 Roof assemblies

4.3.6.2.3 Reflective insulation shall be installed and supported:

a) with the necessary airspace in accordance with table 9 in order to achieve the required *R*-value between a reflective side of the reflective insulation and a building lining or cladding,

b) with the reflective insulation tightly fitted and taped against any penetration, door or window opening, and

Requirements

Table 9 — *R*-values considered to be achieved by reflective foil laminates

1	2	3	4	5	6	7	8
Emissivity of added reflective insulation	Direction of heat flow	*R*-value added by reflective foil insulation					
		Pitched roof (≥10°) with horizontal ceiling		Flat skillion or pitched roof (≤10°) with horizontal ceiling	Pitched roof with cathedral ceilings °C		
		Natural ventilated roof space	Non-ventilated roof space		22°	30°	45°
0,2 outer 0,05 inner	Downwards	1,21	1,12	1,28	0,96	0,86	0,66
0,2 outer 0,05 inner	Upwards	0,59	0,75	0,68	0,72	0,74	0,77
0,9 outer 0,05 inner	Downwards	1,01	0,92	1,06	0,74	0,64	0,44
0,9 outer 0,05 inner	Upwards	0,40	0,55	0,49	0,51	0,52	0,53

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4.3.6 Roof assemblies

NOTE 1 Reflective foil insulation values include a 15 mm air gap (see BCA 2007). Reflective insulation should work in conjunction with an air gap to be effective.

NOTE 2 The reflective surface with the lowest emissivity should preferably be facing downwards.

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4.3.6 Roof assemblies

4.3.6.2.4 Bulk insulation shall be installed so that

a) it maintains its position and thickness, other than where it crosses roof battens, water pipes or electrical cabling, and

b) in ceilings, it overlaps the wall member by not less than 50 mm, or is tightly fitted against a wall where there is no insulation in the wall. Table 10 gives typical data and deemed-to-satisfy thicknesses of generic insulation products.

Requirements

Table 10 – Typical data and deemed-to-satisfy thicknesses of generic insulation products

<table>
<tr><td colspan="3">1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td></tr>
<tr><td colspan="3" rowspan="2">Description</td><td colspan="6">Climatic zones</td></tr>
<tr><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td></tr>
<tr><td colspan="3">Minimum required total R-value m^2.K/W</td><td>3,7</td><td>3,2</td><td>2,7</td><td>3,7</td><td>2,7</td><td>3,5</td></tr>
<tr><td colspan="3">Direction of heat flow</td><td>Up</td><td>Up</td><td>Down and Up</td><td>Up</td><td>Down</td><td>Up</td></tr>
<tr><td colspan="3">Estimated total R-value (m^2.K/W) of roof and ceiling materials (Roof covering and plasterboard only)</td><td colspan="4">0,35 to 0,40</td><td>0,41 to 0,53</td><td>0,35 to 0,40</td></tr>
<tr><td colspan="3">Estimated minimum added R-value of insulation (m^2.K/W)</td><td colspan="4">2,30 to 3,35</td><td>2,15 to 2,29</td><td>3,10 to 3,15</td></tr>
<tr><td>Generic insulation products</td><td>Density kg/m^3</td><td>Thermal Conductivity W/m.K</td><td colspan="6">Recommended deemed to satisfy minimum thickness of insulation product mm</td></tr>
</table>

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Table 10 – Typical data and deemed-to-satisfy thicknesses of generic insulation products

Generic insulation products	Density kg/m^3	Thermal Conductivity W/m.K	Recommended deemed to satisfy minimum thickness of insulation product mm					
Cellulose fibre loose fill	27,5	0,040	135	115	100	135	100	130
Flexible fibre glass blanket	10 to 18	0,040	135	115	100	135	100	130
Flexible BOQ polyester fibre blanket	24	0,038	130	110	90	130	90	125
Flexible polyester blanket	11,5	0,046	160	140	120	160	110	150

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Table 10 – Typical data and deemed-to-satisfy thicknesses of generic insulation products

Generic insulation products	Density kg/m^3	Thermal Conductivity W/m.K	Recommended deemed to satisfy minimum thickness of insulation product mm					
Flexible mineral/ rockwool	60 to 120	0,033	115	100	80	115	80	100
Flexible ceramic fibre	84	0,033	115	100	80	115	80	100
Rigid expaned polystyrene (EPS)SD	15	0,035a	120	100	90	120	80	115
Rigid extruded polystyrene (XPS)	32	0,028a	100	80	70	100	65	90

Table 10 – Typical data and deemed-to-satisfy thicknesses of generic insulation products

Generic insulation products	Density kg/m^3	Thermal Conductivity W/m.K	Recommended deemed to satisfy minimum thickness of insulation product mm					
Rigid fibre glass board	47,5	0,033	115	100	80	115	80	100
Rigid BOQ polyester fibre board	61	0,034	115	100	80	115	80	100
Rigid polystyrene board	32	0,025a	85	70	60	85	60	80
NOTE The deemed-to-satisfy recommended levels of insulation can be achieved by the use of reflective foils, bulk insulation or rigid board insulation or in combination with one another. Maximum efficiency may be achieved at reduced thicknesses taking the aforementioned into account								
a Thermal efficiencies are dependant on material thickness, density, age, operating temperature and moisture.								

Table F.2 – Typical *R*-values for air spaces and films

1	2	3	4
Air spaces non reflective unventilated	Position of air space	Direction of heat flow	*R*-value
	Pitched roof space	Up	0,18
	Pitched roof space	Down	0,28
	Horizontal	Up	0,15
	Horizontal	Down	0,22
	45° slope	Up	0,15
	45° slope	Down	0,18
	Vertical	Horizontal	0,16
	Pitched roof space	Up	Nil
	Pitched roof space	Down	0,46
	Horizontal	Up	0,11
	Horizontal	Down	0,16
	45° slope	Up	0,11
	45° slope	Down	0,13
	Vertical	Horizontal	0,12
Air films – Moving air	7m/s wind	Any direction	0,03
	3m/s wind	Any direction	0,04

Table F.3 – Typical *R*-values for roof and ceiling construction

1	2	3	4	5	6
Roof construction description	Component	R-value unventilated		R-value ventilated	
		Up	Down	Up	Down
Roof 22° to 45° pitch with – horizontal ceiling, and – metal cladding	Outdoor air film (7m/s)	0,03	0,03	0,03	0,03
	Metal cladding	0	0	0	0
	Roof air space (non-reflective)	0,18	0,28	0	0,46
	Plasterboard, gypsum (10 mm, 880 kg/m³)	0,06	0,06	0,06	0,06
	Indoor air film (still air)	0,11	0,16	0,11	0,16
	Total R-value	0,38	0,53	0,20	0,71
Roof 22° to 45° pitch with – horizontal ceiling, and – clay tiles 19 mm	Outdoor air film (7m/s)	0,03	0,03	0,03	0,03
	Roof tile, clay or concrete (1922 kg/m³)	0,02	0,02	0,02	0,02
	Roof air space (non-reflective)	0,18	0,28	0	0,46
	Plasterboard, gypsum (10 mm, 880 kg/m³)	0,06	0,06	0,06	0,06
	Indoor air film (still air)	0,11	0,16	0,11	0,16
	Total R-value	0,40	0,55	0,22	0,73

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Thermal Conductivity = K-value = W/m.K

$$\frac{\text{Thermal Conductivity}}{\text{Thickness of material}} = \text{U-value}$$

$$U = \frac{1}{R} \qquad R = \frac{1}{U}$$

$$\frac{0.040\ \text{W/m.K}}{1\text{m}} = 0.040\ \text{W/m}^2\text{.K}$$

$$\frac{1}{0.040\ \text{W/m}^2\text{.K}} = 25\ \text{m}^2\text{.K/W}$$

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Zone 1 (UP)

Required: 3.7 $m^2.K/W$

Typical roof = 0.38$m^2.K/W$

$3.7 - 0.38 = 3.32$

$\frac{3.32}{25} = 0.133m \approx 135mm$

$0.38 - 0.06 = 0.32$ (take out ceiling)

$3.7 - 0.32 - 1.00 = 2.38$ (add better ceiling)

$\frac{2.38}{25} = 0.10m \approx 100mm$

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Zone 2 (UP)

Required: 3.2 $m^2.K/W$

Typical roof = 0.38$m^2.K/W$

$$3.2 - 0.38 = 2.82$$

$$\frac{2.82}{25} = 0.113\text{m} \approx 115\text{mm}$$

$$0.38 - 0.06 = 0.32$$ (take out ceiling)

$$3.2 - 0.32 - 1.00 = 1.88$$ (add better ceiling)

$$\frac{1.88}{25} = 0.08\text{m} \approx 80\text{mm}$$

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Zone 3 (UP AND DOWN)

(Worst case = UP + Ventilated)

Required: 2.7 m².K/W

Typical roof = 0.20m².K/W

2.7 – 0.20 = 2.50

$$\frac{2.50}{25} = 0.100\text{m} \approx 100\text{mm}$$

0.20 - 0.06 = 0.14 (take out ceiling)

2.7 – 0.14 - 1.00 = 1.56 (add better ceiling)

$$\frac{1.56}{25} = 0.06\text{m} \approx 60\text{mm}$$

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Zone 4 (UP)

Required: 3.7 m².K/W

Typical roof = 0.38m².K/W

$3.7 - 0.38 = 3.32$

$\frac{3.32}{25} = 0.133\text{m} \approx 135\text{mm}$

$0.38 - 0.06 = 0.32$ (take out ceiling)

$3.7 - 0.32 - 1.00 = 2.38$ (add better ceiling)

$\frac{2.38}{25} = 0.10\text{m} \approx 100\text{mm}$

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Zone 5 (DOWN)

Required: 2.7 m².K/W

Typical roof = 0.71m².K/W (ventilated!!)

$$2.7 - 0.71 = 1.99$$

$$\frac{1.99}{25} = 0.08\text{m} \approx 80\text{mm}$$

$$0.71 - 0.06 = 0.65$$ (take out ceiling)

$$2.7 - 0.65 - 1.00 = 1.05$$ (add better ceiling)

$$\frac{1.05}{25} = 0.04\text{m} \approx 40\text{mm}$$

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Zone 5 (DOWN)

Required: 2.7 m².K/W

Typical roof = 0.53m².K/W (unventilated)

$$2.7 - 0.53 = 2.17$$

$$\frac{2.17}{25} = 0.087\text{m} \approx 90\text{mm}$$

$0.53 - 0.06 = 0.47$ (take out ceiling)

$2.7 - 0.47 - 1.00 = 1.23$ (add better ceiling)

$$\frac{1.23}{25} = 0.05\text{m} \approx 50\text{mm}$$

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Zone 6 (UP)

Required: 3.5 m².K/W

Typical roof = 0.38m².K/W

$$3.5 - 0.38 = 3.12$$

$$\frac{3.12}{25} = 0.125\text{m} \approx 125\text{mm}$$

0.38 - 0.06 = 0.32 (take out ceiling)

3.5 - 0.32 - 1.00 = 2.18 (add better ceiling)

$$\frac{2.18}{25} = 0.087\text{m} \approx 90\text{mm}$$

Requirements

4.3.7 Roof lights

Roof lights serving a habitable room, public area or an interconnecting space such as a corridor, hallway or stairway shall

a) if the total area of roof lights is more than 1,5 % but not more than 10 % of the floor area or space they serve, comply with table 11; and

b) if the total area of roof lights is more than 10 % of the floor area of the room or space they serve, only be used where the transparent and translucent elements of the roof lights, including any imperforate ceiling diffuser, achieves an *SHGC* of not more than 0,25 and a total *U*-value of not more than 2,0.

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Requirements

4.3.7 Roof lights

NOTE The thermal performance of an imperforate ceiling diffuser may be included in the total *U*-value of a roof light.

a The roof light shaft index is determined by measuring the distance from the centre of the shaft at the roof to the centre of the shaft at the ceiling level and dividing it by the average internal dimension of the shaft opening at the ceiling level (or the diameter for a circular shaft) in the same unit of measurement.

Requirements

Table 11 — Roof lights – Thermal performance of transparent and translucent elements

1	2	3	4	5	6	7
roof light shaft index[a]	total area of roof lights serving the room or space as a percentage of the floor area of the room or space					
	1,5% to 3%		3% to 5%		5% to 10%	
	SHGC	Total U-value	SHGC	Total U-value	SHGC	Total U-value
< 0,5	≤ 0,75	≤ 5,0	≤ 0,50	≤ 5,0	≤ 0,25	≤ 2,5
0,5 < 1,0	=		≤ 0,70		≤ 0,35	
1,0 < 2,5	=		=		≤ 0,45	
> 2,5	=		=		=	

NOTE 1 The total area of roof lights is the combined area for all roof lights serving the room or space.

NOTE 2 The area of a roof light is the area of the roof opening that allows light to enter the building

Requirements

EXAMPLE 1

SHAFT INDEX

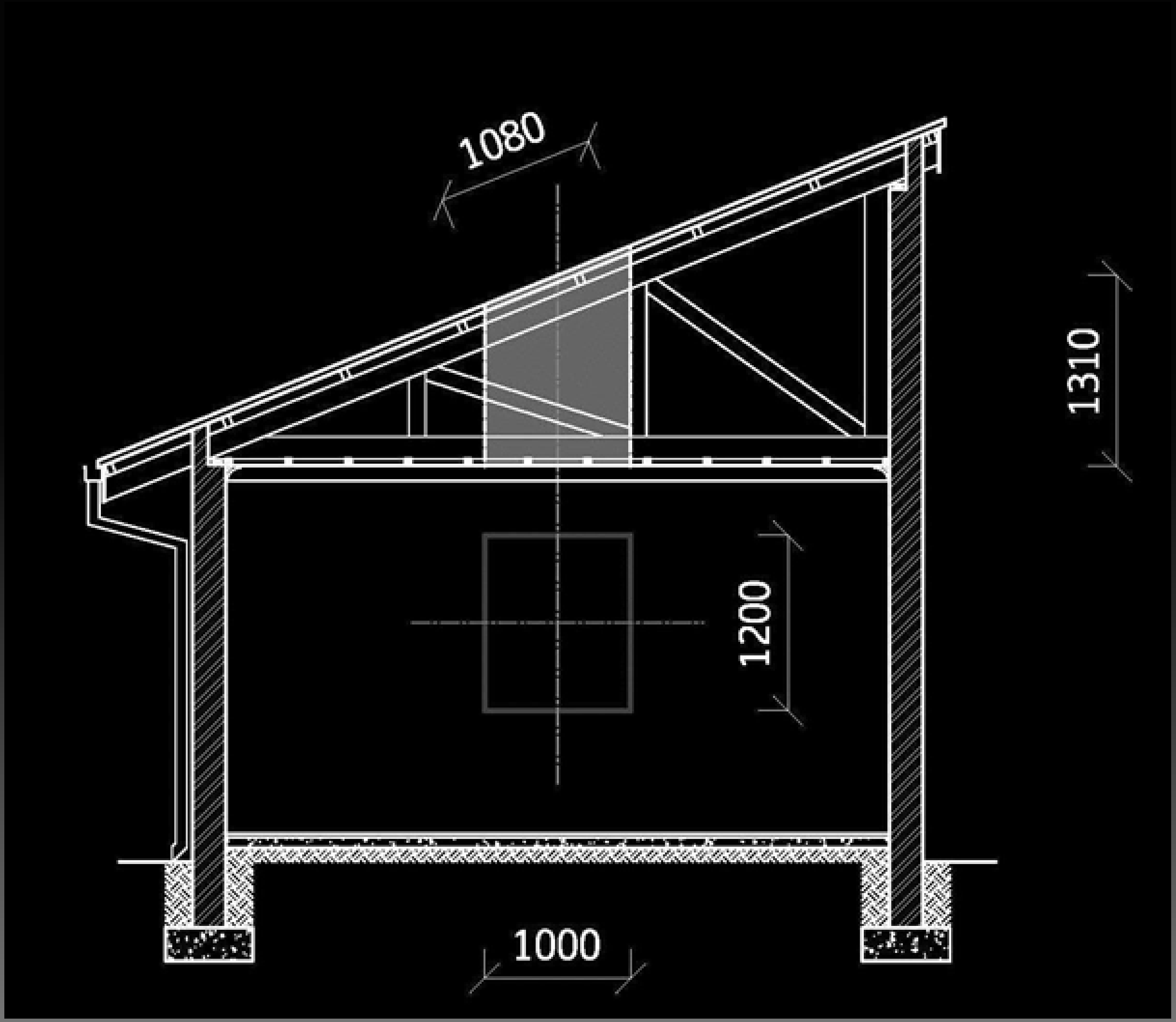
$$\frac{1310}{(1000 + 1200)/2}$$

= 1310/1100

= 1.19

% OF FLOOR AREA

(1.08 x 1.2)/25 (Note 2)
= 1.30/25
= 5.20%



Requirements

EXAMPLE 2

SHAFT INDEX

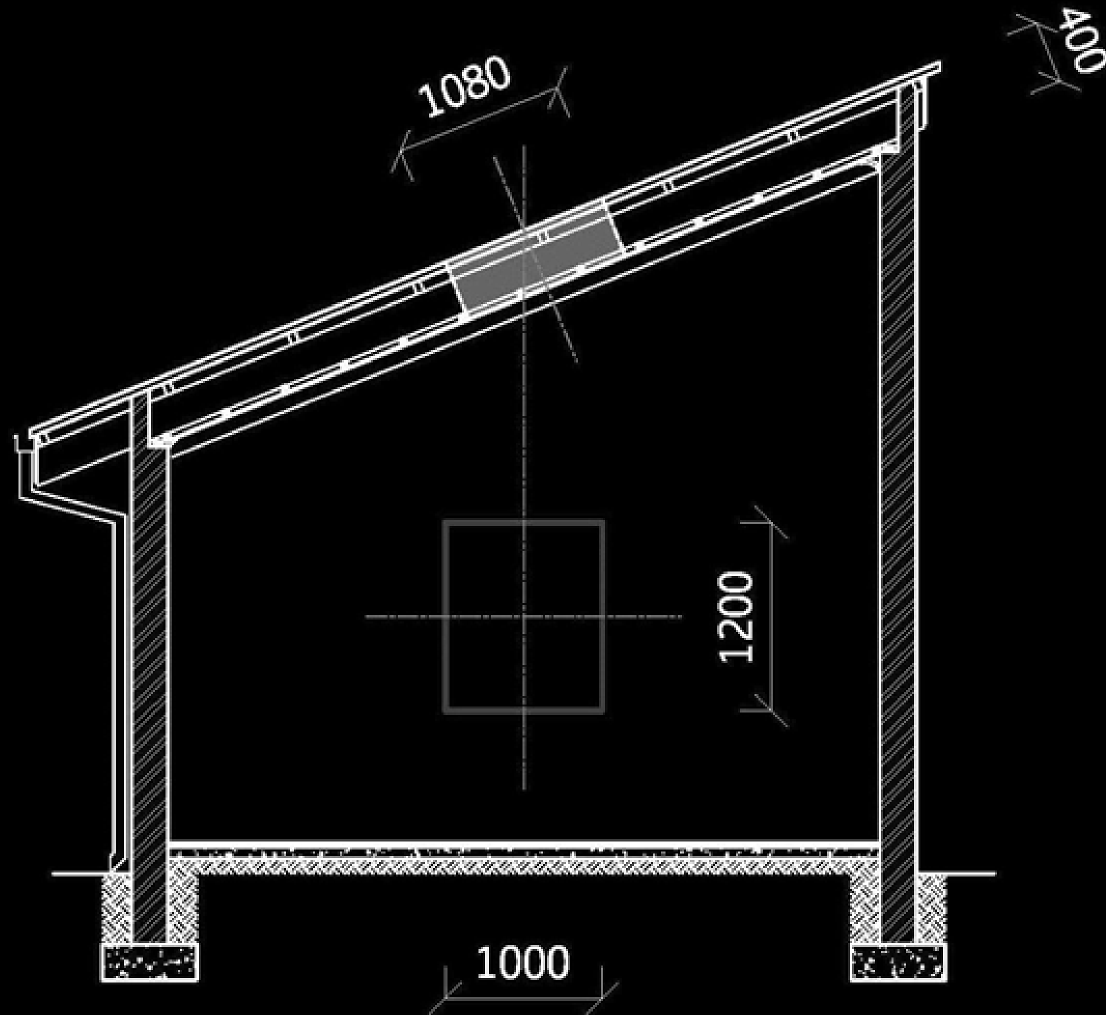
$$\frac{400}{(1000 + 1200)/2}$$

= 400/1100

= 0.36

% OF FLOOR AREA

(1.08 x 1.2)/25 (Note 2)
= 1.30/25
= 5.20%



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Regulation

5 Add the following new regulation Part X:

Part X: Environmental sustainability

Part XA: Energy usage in buildings

REGULATION

(a) are capable of using energy efficiently while fulfilling user needs in relation to vertical transport, if any, thermal comfort, lighting and hot water; or

(b) have a building envelope and services which facilitate the efficient use of energy appropriate to its function and use, internal environment and geographical location.

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Requirements

4.5 Services

4.5.1 Lighting and power

4.5.1.1 Depending upon occupancy and activity, the minimum lighting levels shall be determined in accordance with the requirements of SANS 10114-1 and SANS 10400-O.

Compliance with the relevant national legislation (see foreword) is necessary for safety.

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Requirements

4.5 Services

4.5.1 Lighting and power

4.5.1.1 Depending upon occupancy and activity, the minimum lighting levels shall be determined in accordance with the requirements of SANS 10114-1 and SANS 10400-O.

Compliance with the relevant national legislation (see foreword) is necessary for safety.

4.5.1.2 Designers are encouraged to use daylighting in their designs to reduce the energy used.

4.5.1.3 The energy demand (power) and energy consumption for the building shall be determined in accordance with the requirements given in table 12.

Requirements

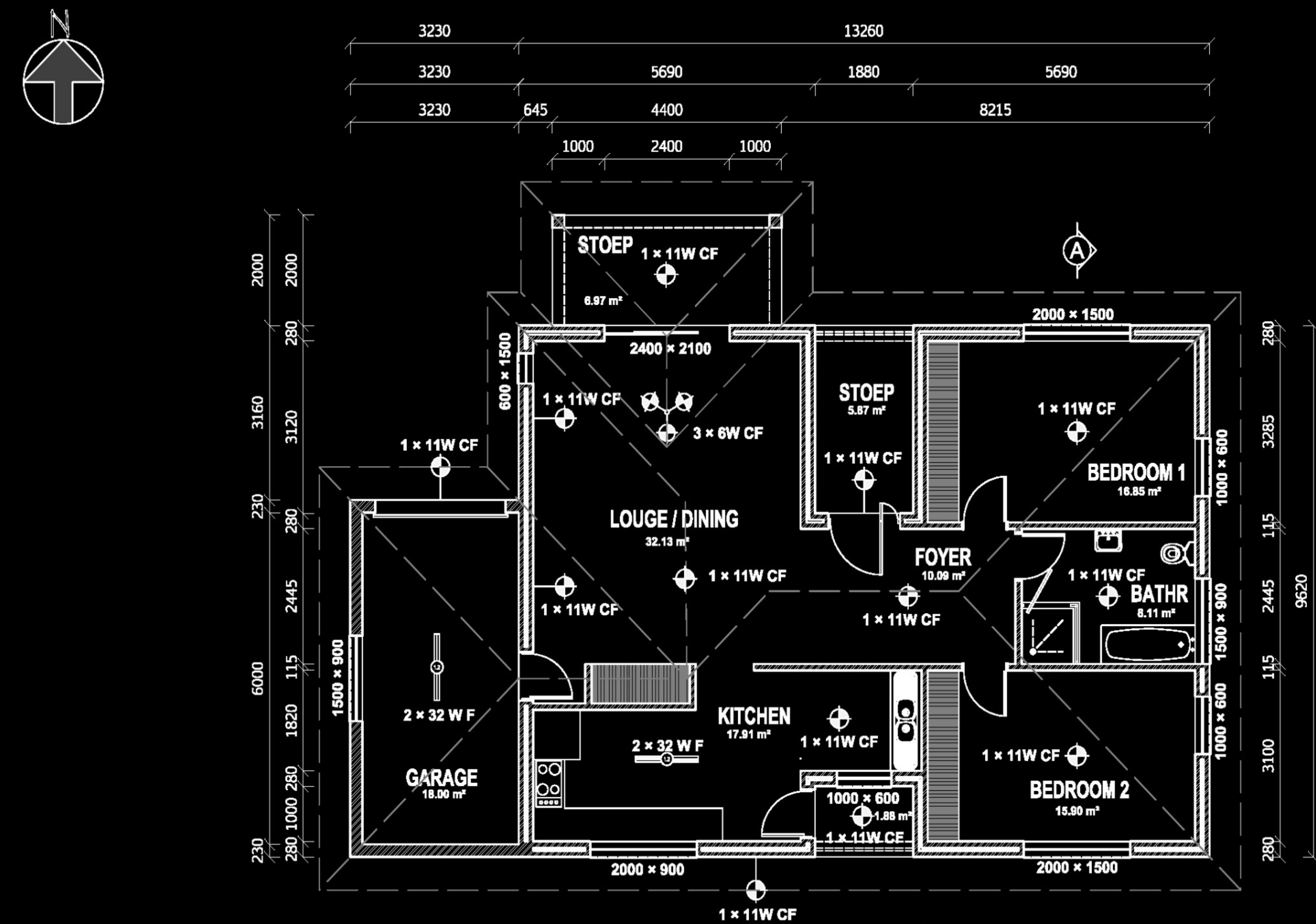
Table 12 - Maximum energy demand and energy consumption for lighting for the class of occupancy or buildings

Class of occupancy or building	Occupancy	Population	Energy Demand W/m²	Energy consumption kWh/(m²·a)
A1	Entertainment and public assembly	Number of seats or 1 person/m²	10	25
A2	Theatrical and indoor sport	Number of seats or 1 person/m²	10	25
A3	Places of instruction	1 person/5 m²	10	25
A4	Worship	Number of seats or 1 person/m²	10	10
A5	Outdoor sport is viewed	Number of seats or 1 person/m²	10	15
B1	High-risk commercial	1 person/15 m²	24	60
B2	Moderate-risk commercial	1 person/15 m²	20	50
B3	Low-risk commercial	1 person/15 m²	15	37,5
C1	Exhibition Halls	1 person/10 m²	15	22,5
C2	Museums	1 person/20 m²	5	12,5
D1	High-risk industrial	1 person/15 m²	20	50
D2	Moderate-risk industrial	1 person/15 m²	20	50
D3	Low-risk industrial	1 person/15 m²	15	37,5
D4	Plant rooms	N/A	5	5
E1	Places of detention	2 people/bedroom	15	37,5
E2	Hospitals	1 person/10 m²	10	87,6

Requirements

Table 12 - Maximum energy demand and energy consumption for lighting for the class of occupancy or buildings

Class of occupancy or building	Occupancy	Population	Energy Demand W/m²	Energy consumption kWh/(m²·a)
E3	Other institutional residences	1 person/10 m²	10	25
E4	Health care	1 person/10 m²	10	87,6
F1	Large shops	1 person/10 m²	24	105,12
F2	Small shops	1 person/10 m²	20	87,6
F3	Wholesaler's store	1 person/20 m²	15	65,7
G1	Offices	1 person/15 m²	17	42,5
H1	Hotels	2 people/bedroom	10	43,8
H2	Dormitories	1 person/5 m²	5	12,5
H3	Domestic residences	2 people/bedroom	5	5
H4	Dwelling houses	4 people/house	5	5
H5	Hospitality	2 people/bedroom	10	43,8
J1	High-risk storage	1 person/50 m²	17	42,5
J2	Moderate risk storage	1 person/50 m²	15	37,5
J3	Low-risk storage	1 person/50 m²	7	17,5
J4	Parking areas covered	1 person/50 m²	5	21,9



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LIGHTING

ENERGY DEMAND:

ALLOWED: $5W/m^2$

$5W/m^2 \times 157.23m^2 = 786.15W$

13 × 11W lamps	=	143
3 × 6W lamps	=	18
4 × 32W lamps	=	<u>128</u>
		289W

or

$289W / 157.23m^2 = 1.84W/m^2$

($<5W/m^2$)

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ENERGY CONSUMPTION:

ALLOWED: $5kWh/m^2.a$ or $5kWh/m^2$ [a = 1 (year)]

$5kWh/m^2.a \times 157.23m^2 = 786.15kWh.a$

Assume lights are on from 17:00 – 22:00 each day/year , that is 5h/day

52 (weeks) × 7 (days) × 5 (h) = 1 820h.a

Lamps = 289W or 0.289kW

0.289kW × 1 820h.a = 525.98kWh.a
(< 786.15kWh.a √)

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Energy Efficient Light Bulb Comparison

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