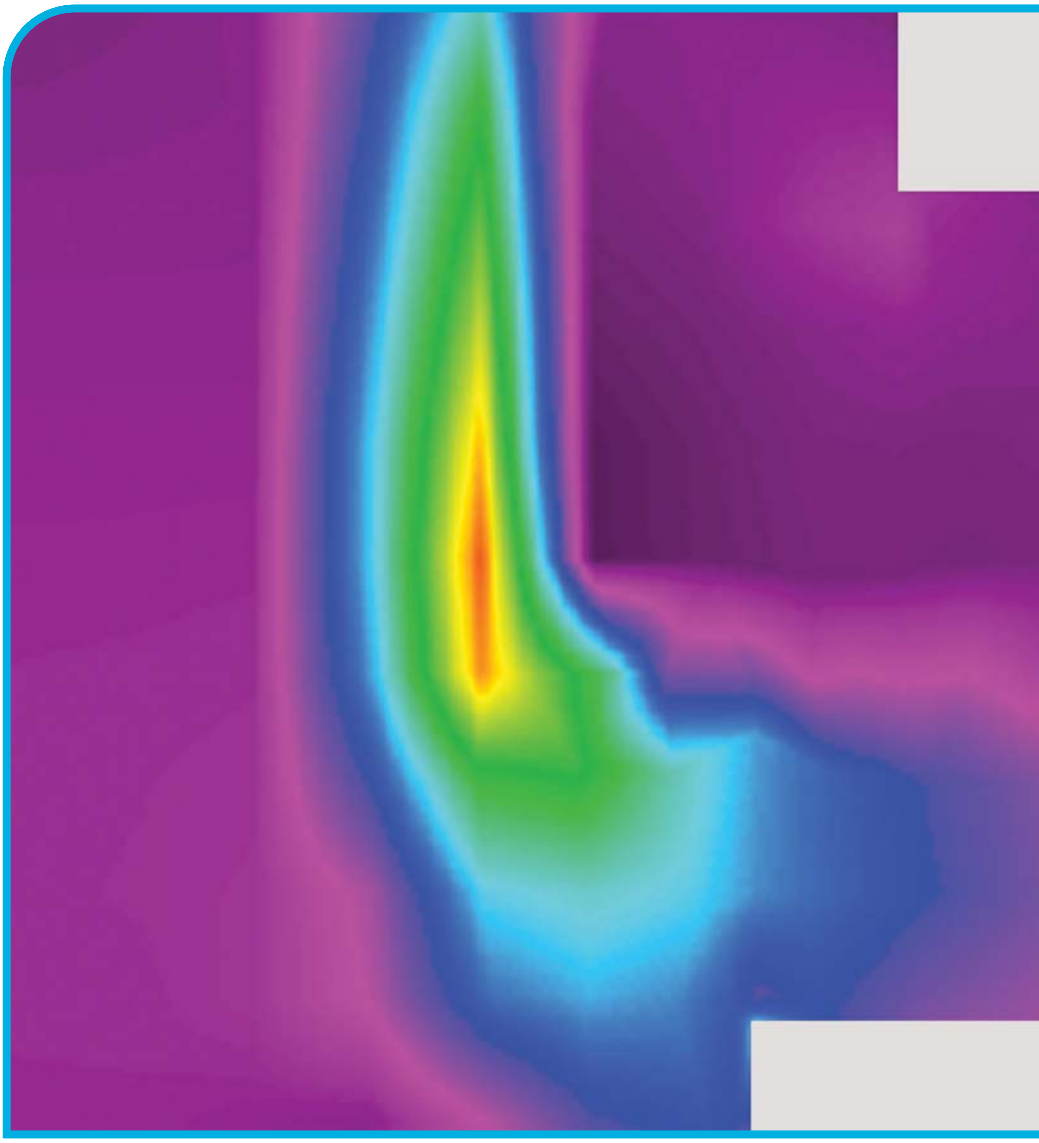
AECB CarbonLite Programme

Delivering buildings with excellent energy and CO_2 performance

VOLUME FIVE: STEPS TWO & THREE DESIGN GUIDANCE
Passivhaus / Gold Standard

Version 1.0.0



AECB CarbonLite

CARBON LITERATE DESIGN AND CONSTRUCTION

Contents

Glossary of main terms

Heat Loss Parameter (HLP)
The building's specific heat loss (in units of W/K) divided by the building's floor area (measured internally – i.e. within the thermal envelope). Units W/K.m²

ψ – (psi) value
Linear thermal bridge heat loss coefficient, units W/mK

Note that the psi values in this document have all been calculated with respect to the inside to outside temperature difference, not the inside to ground temperature difference as recommended in the PHPP2007 manual. Consequently, these all need to be entered in PHPP 2007 in the Areas worksheet as 'Category 15 Thermal bridges to ambient'; not 'thermal bridges to ground/perimeter'.

λ – (lambda) value
Thermal conductivity of a material, units W/mK

K – (kay) value
Alternative symbol for thermal conductivity of a material, units W/mK

χ – (chi) value
Point thermal bridge heat loss coefficient, units W/K

R-value
Thermal resistance, units m²W/K

U-value
Thermal transmittance, units W/m²K

EPS
Expanded polystyrene

XPS
Extruded polystyrene

PU/PI foam
Polyurethane or polyisocyanurate foam

Contents (cont)

Glossary of main terms (Cont)

CarbonLite
The AECB's Carbon Literate Design and Construction Programme

Silver Standard -
A low energy building standard used in CarbonLite Step 1.

Passivhaus Standard
A low energy building standard used in CarbonLite Step 2.

Gold Standard
A low energy building standard used in CarbonLite Step 3.

Passivhaus Institut (PHI)
A German research and consultancy establishment, the originator of the Passivhaus movement and of the Passivhaus Standard.

Passivhaus Planning Package (PHPP)
A modelling and accreditation software tool developed and updated by the Passivhaus Institut.

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1.0.0: Introduction

SECTION 1

CarbonLite Gold and Passivhaus Standard construction design guidance

This document has been issued to support all those who are adopting the AECB's CarbonLite Standards. It is assumed that the reader of this document has already read the *Silver Standard Design Guidance*. Not all text which is introduced there is repeated here. As with the earlier Silver guidance, CarbonLite Volume 5 concentrates on the two respects in which UK buildings most singularly fail to perform well in a thermal sense; i.e., poor airtightness and high thermal bridging. The design and constructional principles in this document will be valuable to all those who are seeking to design better-performing thermal envelopes.

It is intended that this guidance should be treated as showing 'constructional examples' only, detailed to illustrate the applications of sound thermal design principles, as required by CarbonLite Step 2 (Passivhaus) and CarbonLite Step 3 (Gold). Do not treat them as 'approved' or 'accredited' details, as they have not yet been through the necessary peer review process to gain this additional authority.

Please use the examples herein to inform the detailed design of the building fabric of your own projects. Applying the principles of reduced thermal bridging and improved airtightness to all elements of the fabric - roofs, external walls, ground floors - and the junctions between elements will significantly reduce your building's overall energy use and CO_2 emissions.

Working with the CarbonLite Standards

The guidance is written in the context of constructional examples based on typical Passivhaus or Gold Standard U-values. There is frequent reference to CarbonLite Step 3, Gold Standard, but the guidance covers issues which are equally pertinent to CarbonLite Step 2, Passivhaus Standard. The two standards are thermally very similar. Both of them require insulation thicknesses which are well above the UK's normal or accepted levels as required by current Building Regulations.

The main difference between the Passivhaus and Gold Standards is that Gold requires more energy-efficient electrical appliances or office equipment, lighting and HVAC pumps, fans and controls than does Passivhaus. Therefore, the internal heat gains in a Gold Standard building tend to be slightly lower. Consequently, to keep the useful space heating energy to no more than 15 kWh/m^2.yr, the building's specific heat loss must be slightly lower than it needs to be for a Passivhaus building.

U-values

The examples in this guidance are based on a number of construction methods and materials, namely load-bearing solid walls, concrete-frame and timber-frame.

All the constructions illustrated allow a degree of design modification to achieve the typical ranges of U-values required by Passivhaus and Gold Standard buildings.

Typical junctions between basic construction elements of the external building fabric – walls, roofs, floors – are illustrated.

- The exact U-value required for a specific element of a project's external fabric is determined by the maximum Heat Loss Parameter (HLP) set by the standard.
- The U-values listed in the standards are *upper* limits. A compact building with a low surface-to-volume ratio, such as a block of flats, may achieve the required HLP with near the maximum U-values, whereas a less compact building, such as a small detached house, would need lower U-values.[1]

In each Section, **U-values** are given for the 'plane elements'; e.g. masonry wall, timber wall, timber roof, etc, and ψ-values are given for junctions between these elements; e.g., masonry wall meets timber roof.

Real U-values

In some types of construction, especially timber, the impact of design standards and the reslting positioning and sizing of timber components has a significant impact on the U-value. For this reason the guidance quotes a range of U-values for some of the detailed constructions shown, based on 'good', 'typical' and 'poor' scenarios.

The underlying assumptions behind these U-values can be found in the appendices. They concern the proportion of each layer of the insulation zone which is taken up by solid timber, OSB or plywood instead of by thermal insulation. Small changes are enough to affect the space heating energy use of a low energy building by 5-10%.

ψ-values

The ψ-values are quoted both with reference to internal dimensions and with reference to external dimensions. The second convention is normally used in PHPP. If one is using the latter convention, then provided that no ψ-values are more than 0.01 W/mK the designer may consider the building to be 'thermal bridge-free'.

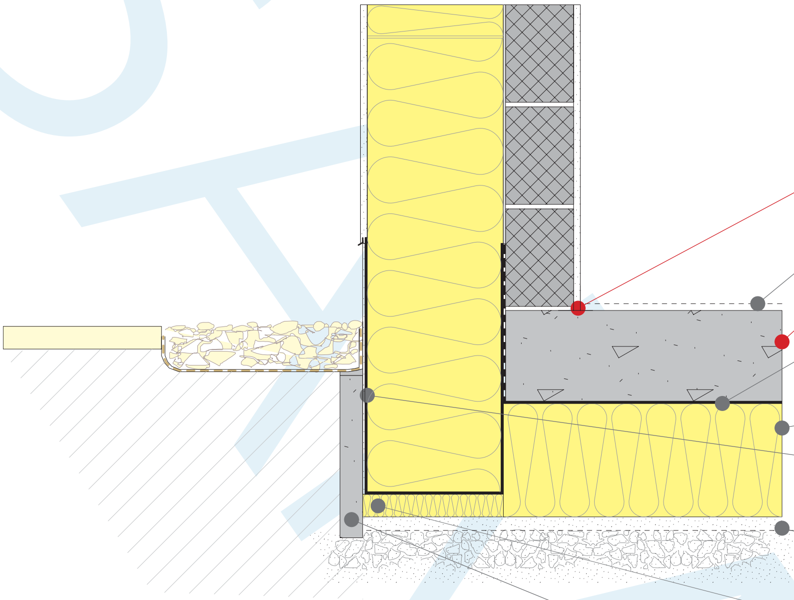
Please note that this rule does not apply if the designer is using internal dimensions. Using internal dimensions intrinsically tends to understate a building's heat loss. If a designer is measuring the areas of external walls, floors, roofs, etc with reference to internal dimensions, even small thermal bridges need to be included to avoid quoting an overoptimistic result.

Further development of the guidance

There will be further editions of this guidance over time, illustrating a greater range of construction types, methods and materials and critical building fabric details. Future details may for example include cavity masonry walls with sufficient insulation for the Passivhaus or Gold Standards, steel-frame construction and walls of aerated concrete blocks. Check the website for notification of dates of publication.

[1] Please refer to CLP Volume Two: Principles and methodologies for calculating and minimising heat loss and CO_2 emissions from buildings while using this document.

2.1.4: Wall to floor junction – MW1 + CF2



GENERAL CONSTRUCTION NOTES

Plaster or parging to blockwork taken down to slab to ensure airtightness

Floor finish not shown

Reinforced concrete slab

Damp proof membrane taken to edge of slab, joined to external waterproof tanking. Tanking taken up external face of slab and blockwork to required height above ground level

250mm expanded polystyrene insulation

External wall insulation incorporating applied layer of waterproof tanking prior to rendering external face of insulation below ground

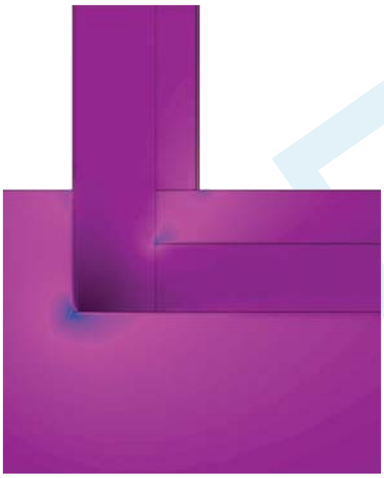
Blinded surface on level sub-base, construction membranes as required

50 mm compressible insulation. NB: lean mix concrete replaces insulation strip at thresholds to provide bearing under wall insulation

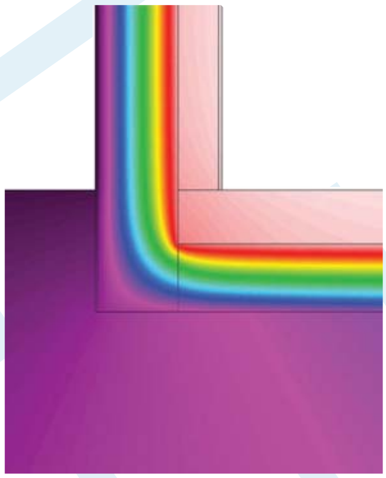
Paving slab or similar to ensure continuity of insulation vermin barrier down to sub base

MW1 + CF2	ψ-value W/mk
ψ internal	0.061
ψ external	-0.047

Flux

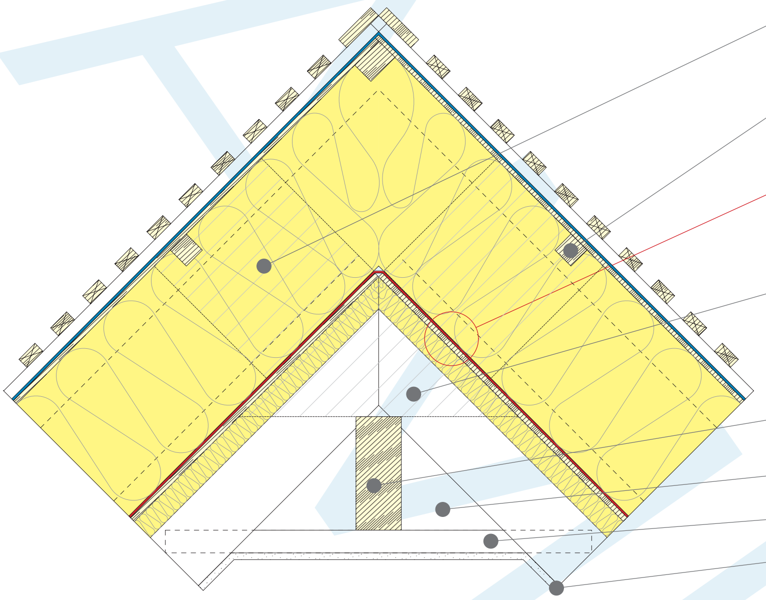


Isotherms



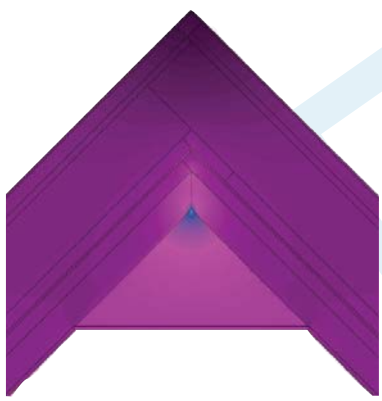
THERM software image of heat flux and isotherms respectively, through MW1 + CF2

4.1.11: Roof ridge junction: TR1 + TR1

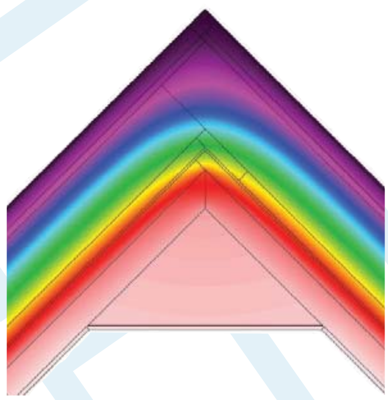


TR1 + TR1	ψ-value W/mk
ψ internal	0.041
ψ external	-0.067

Flux



Isotherms



THERM software image of heat flux and isotherms respectively, through TR1 + TR1.

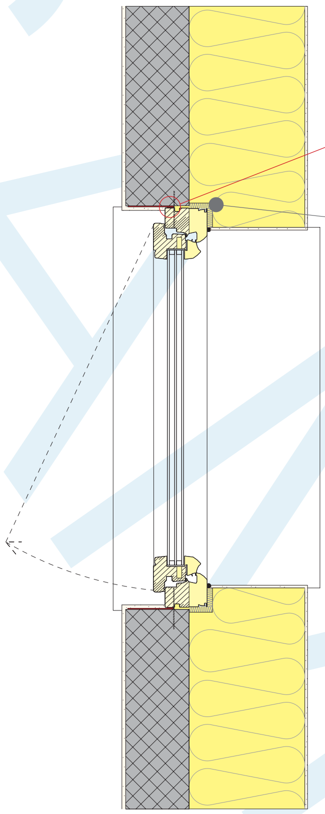
SECTION 5

5.1.0: Inward opening doors and windows

We have illustrated constructional arrangements showing inward opening windows and doors as currently inward opening Passivhaus level products are more widely available in the UK. The triple-glazed window in the constructional examples below incorporates metal-clad thermal insulation on the outer face of the timber window.

5.1.1: Window in MW1: jamb

SECTION 5



JAMB

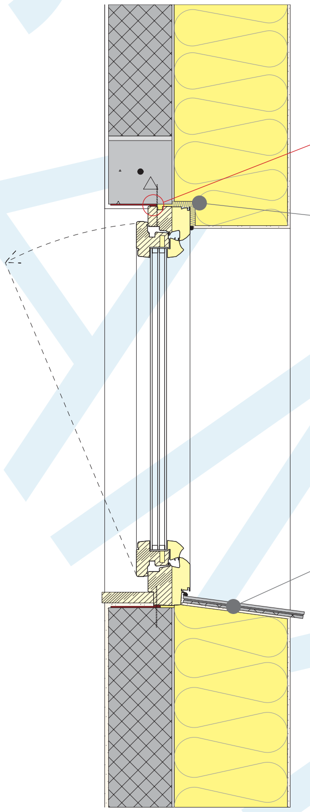
GENERAL CONSTRUCTION NOTES

Air barrier sealed to window before installation and incorporated into wall plaster to achieve an airtight joint

Tolerance gap between window frame and wall insulation - designed to allow full fill insulation giving good thermal integrity to joint, in order to reduce risks of interstitial condensation at this point.

Airtight but vapour permeable membranes should be considered to further reduce risks of interstitial condensation, potentially caused by site defects in the thermal integrity of this joint

5.1.1: Window in MW1: head and cill



HEAD & CILL

GENERAL CONSTRUCTION NOTES

Air barrier sealed to window before installation and incorporated into wall plaster to achieve an airtight joint

Tolerance gap between window frame and wall insulation - designed to allow full fill insulation giving good thermal integrity to joint, in order to reduce risks of interstitial condensation at this point.

Airtight but vapour permeable membranes should be considered to further reduce risks of interstitial condensation, potentially caused by site defects in the thermal integrity of this joint

Proprietary or site made cill piece weathered to window frame and wall jambs