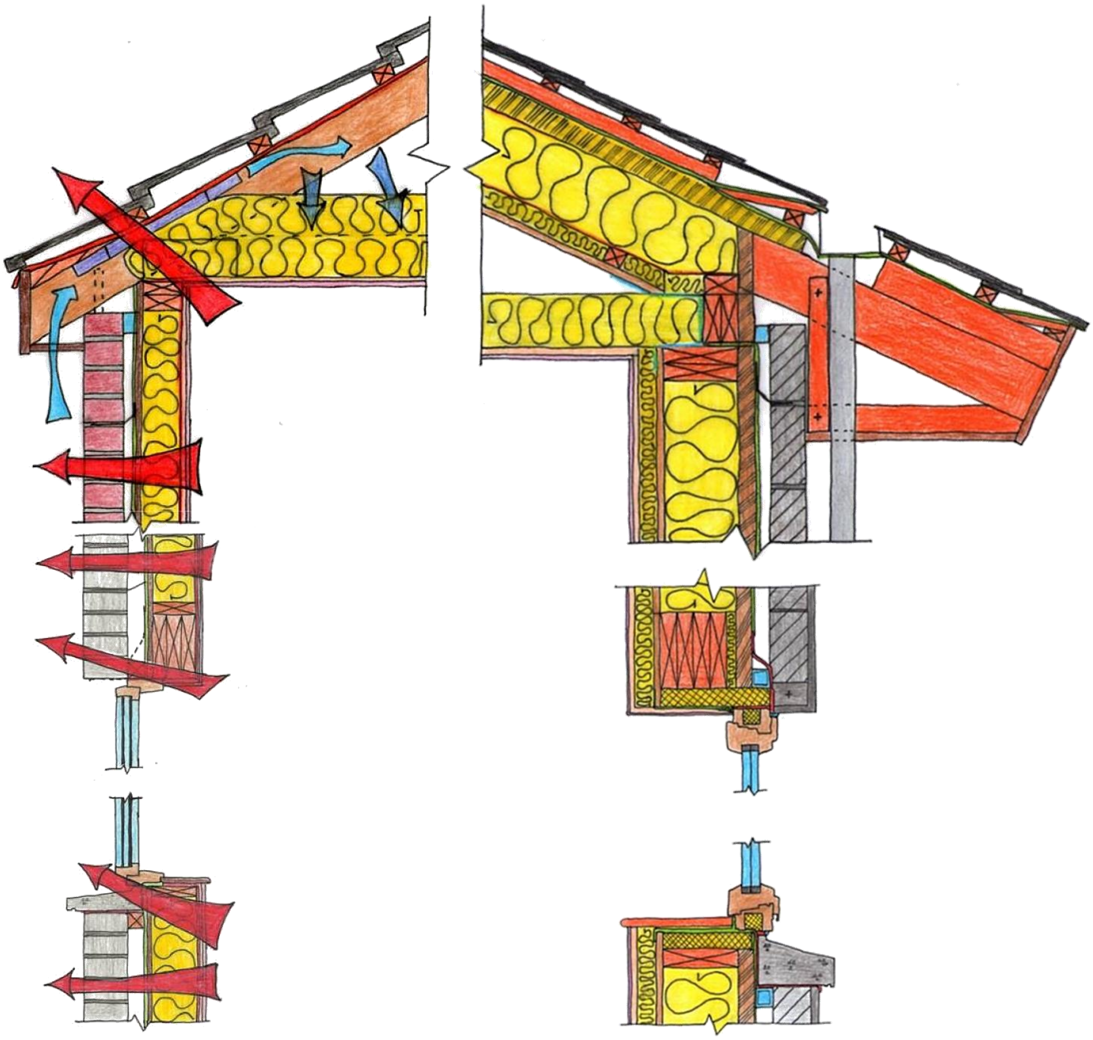
PassiveDesign.org

Passive Construction



About:

This handout contains the information from the "Passive Construction" topic pages on passivedesign.org.

Name:..

Passive Construction

A Passivhaus is a super-insulated, virtually air-tight building that is primarily heated by solar gain and by internal gains (e.g. people, electrical equipment, etc...). It also minimises energy losses by eliminating thermal bridging and using a MVHR which can save up to 90% on space heating costs.

To begin it is crucial to understand that there is a huge difference between a 'Passive House' and a 'Passivhaus'.

A Passive House is simply a house built using the principles of passive design - it is not certified by the Passivhaus Institut. In comparison, a Passivhaus has a stringent standard to abide by. To receive this certification it must achieve the following performance characteristics:

- Total energy demand for space heating and cooling must be less than 15 kWh/m² per year.
- Total energy demand for appliances, hot water, and space heating and cooling must not exceed 120 kWh/m² per year.
- Exterior Insulation must have a U value of less than 15 W/m²K per year.
- Windows must not exceed 0.80 W/m²K
- Airtightness must be less than 0.6 air changes per hour when subject to a force of 50Pa.
- Ventilation must ensure over 80% heat recovery from ventilation exhaust air.

Athenry Passivhaus

Passive Foundations

When building a passive house the first thing you will have to choose is a foundation. The Irish standard for a traditional foundation is a u value of 0.21 W/m^2K whilst the Passivhaus standard is between 0.10 – 0.15 W/m^2K. This simply means that there is less heat loss through the passive foundation.

Below is a list of Passive Foundations that will be examined within the handout:

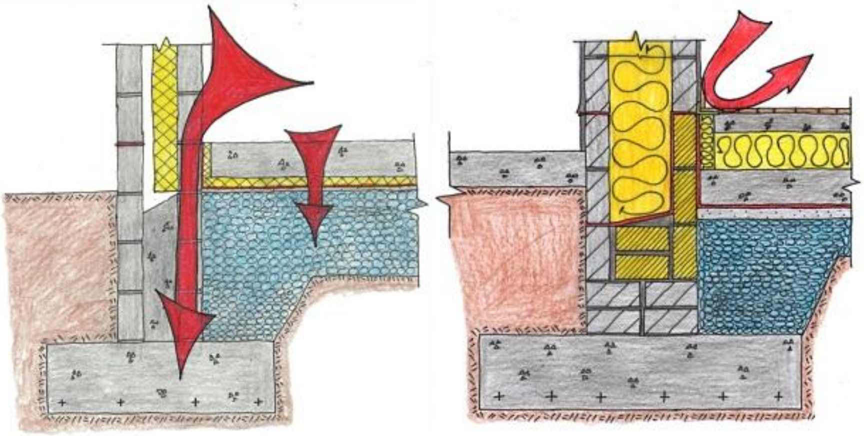
1. Integrated Energy's Passive Strip
2. Viking House (Insulated Ringbeam)
3. Supergrund (Insulated Ringbeam)
4. ISOQUICK (Insulated Raft)

Expanded Polystyrene (EPS)

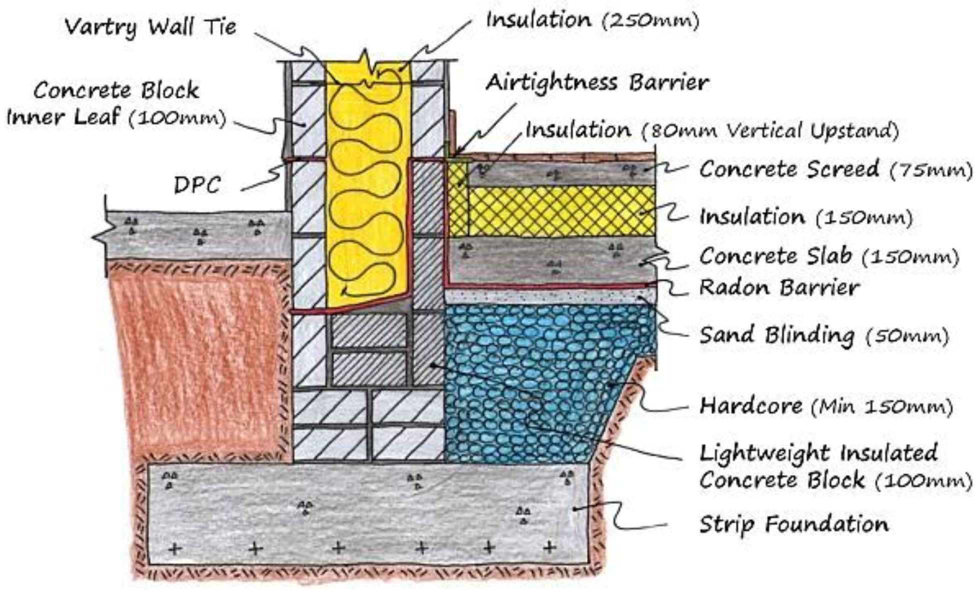
Expanded Polystyrene or EPS comes in different strength grades; mainly EPS300 and EPS100. EPS is of a much higher compressive strength than traditional expanded polystyrene insulation; with EPS300 being able to support loads of up to $120kN/m^2$. This is more than adequate with typical loads from a two-storey dwelling being 45 – $55kN/m^2$.

1. Integrated Energy’s Strip Foundation

In a traditional strip foundation there is heat loss due to a thermal bridge down the inner leaf and also through the floor due to poor levels of insulation. Integrated energy's passive strip foundation aims to eliminate this heat loss. It uses lightweight insulated concrete blocks which prevent thermal bridging down the inner leaf; this is evident from the sketch below. It also uses 150mm of insulation underneath the floor slab to prevent heat loss; the end product of this being a strip foundation that can be used in passivhaus construction.



Below is a simple cross sectional sketch of the passive strip:

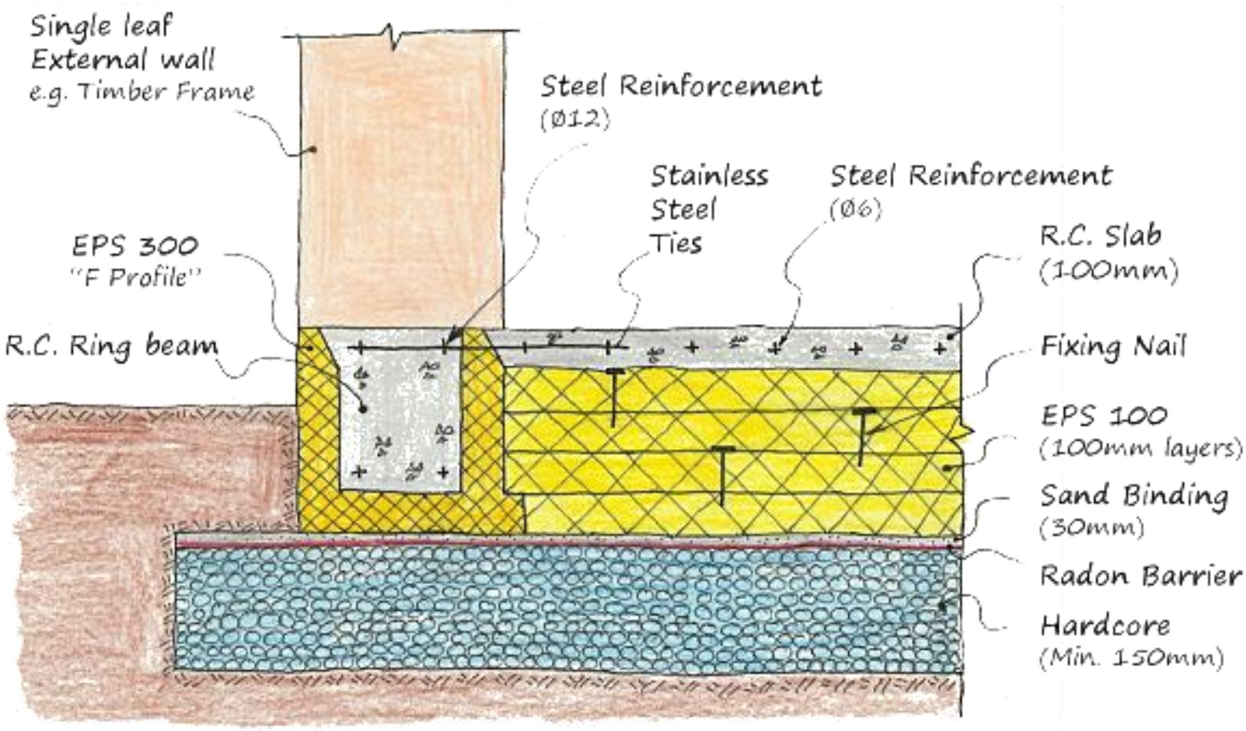


2. Supergrund

This foundation system is unlike the traditional Irish foundations. The Supergrund system is a Swedish design manufactured by Aeroboard Ireland. This system works on the concept of wrapping the entire concrete slab in insulation.

Along the perimeter of the foundation is a high strength "F Profile" insulated (EPS 300) ring beam with the enclosed area being filled with between 300 - 400mm of EPS 100 insulation; ensuring that the entire slab is wrapped in insulation, eliminating thermal bridging (typical u-value 0.100-0.155 W/m2K) and also protecting the structure from moisture.

Below is a simple cross sectional sketch of the system:

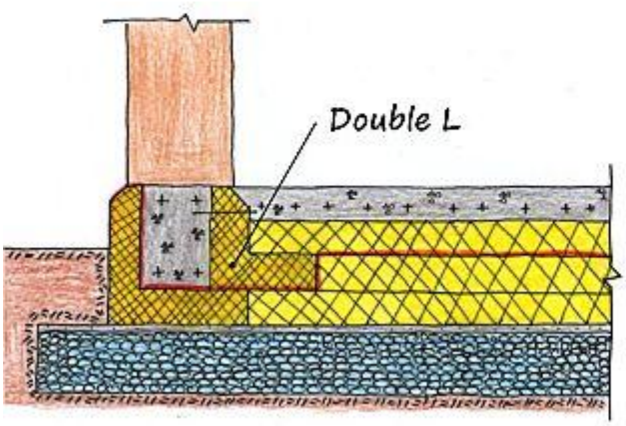


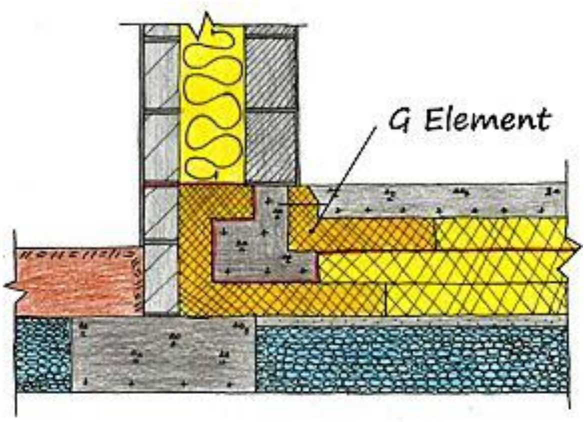
3. Viking House

The Viking House system is very similar to the Supergrund system; an insulated ring beam system.

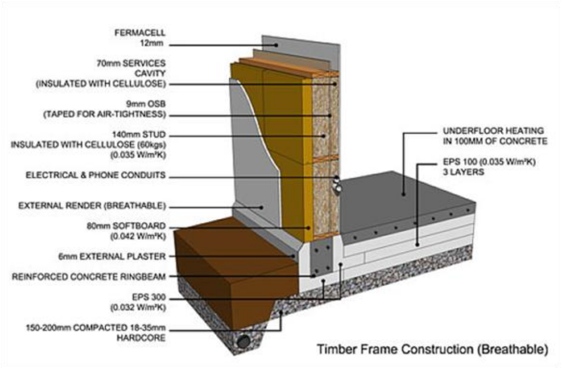
This system works by wrapping the perimeter of the foundation in a high strength insulated (EPS 300) ring beam with the enclosed area being filled typically with 300mm of EPS 100 insulation. This system delivers the lowest U-value on the market (as low as 0.08W/m²K) by eliminating thermal bridging by simply wrapping the entire foundation in insulation. It also protects the structure from moisture and mould growth.

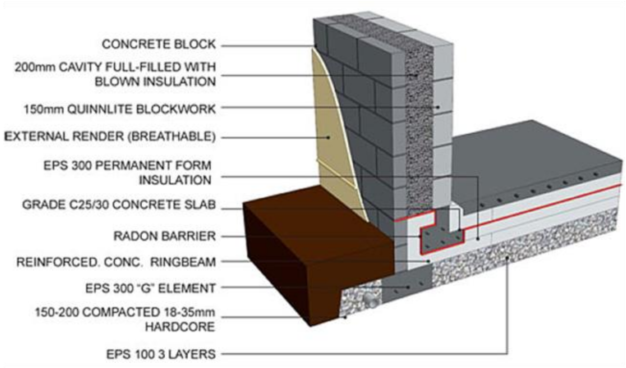
Viking House utilises two main types of profile for their insulated ringbeam foundations:



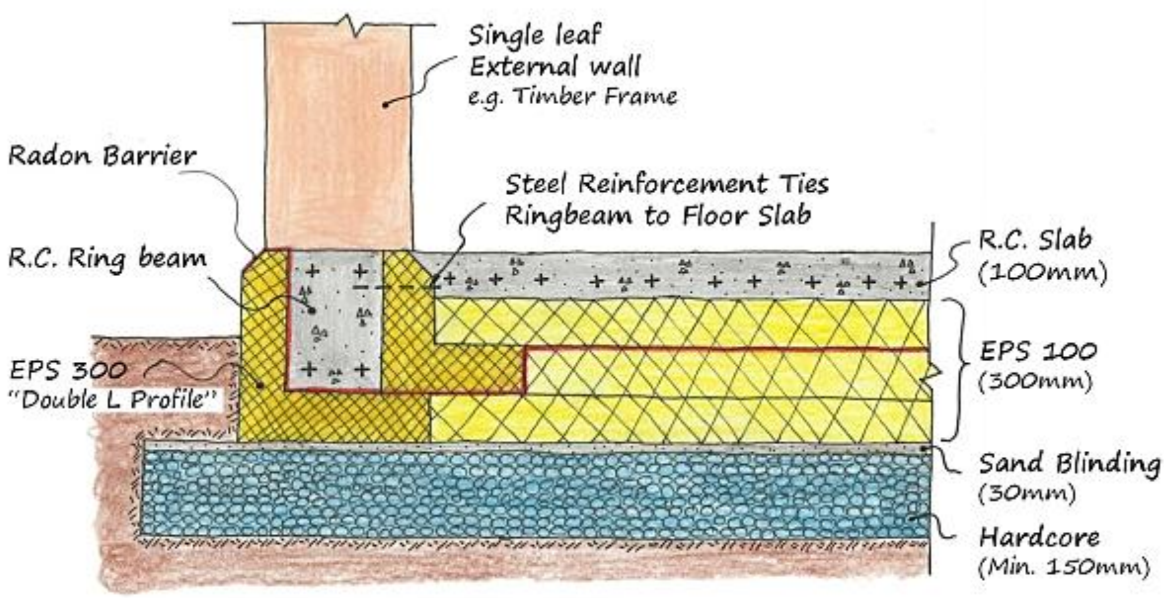


The "Double L" foundation is predominately used in single leaf construction e.g. Timber Frame whilst the "G" foundation is utilised for Block Cavity Construction as seen in the images below:

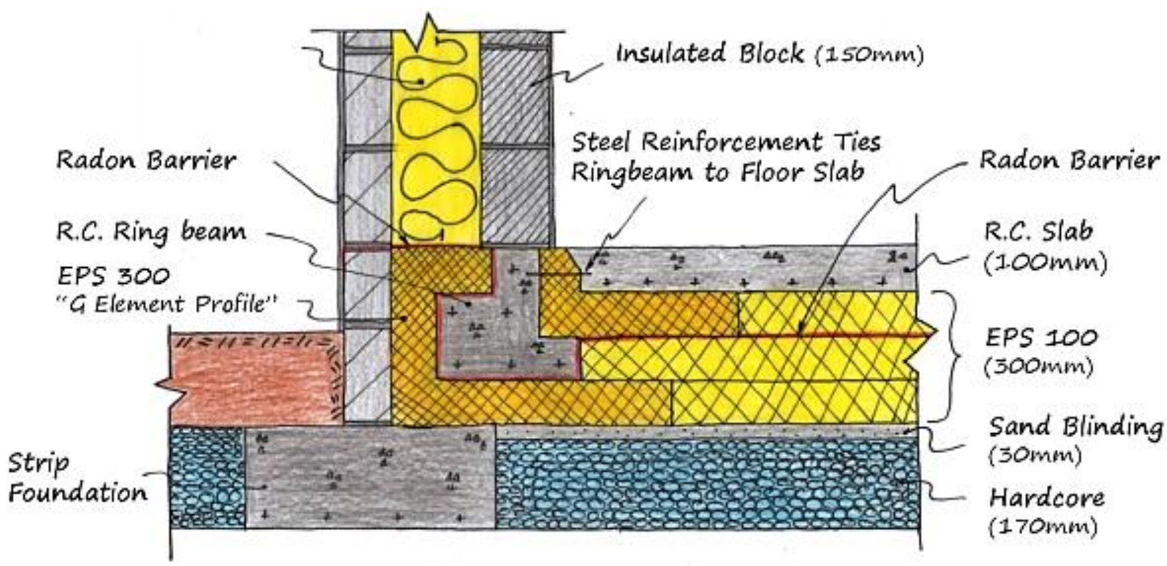




Below is a simple cross sectional sketch of the Double L system:

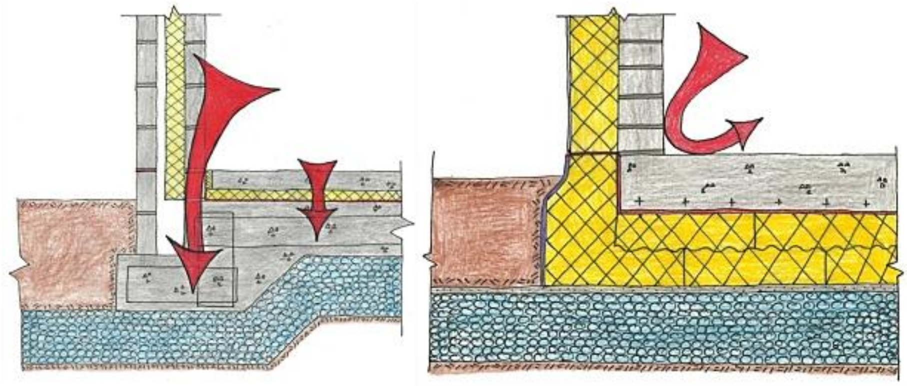


Below is a simple cross sectional sketch of the G element system:



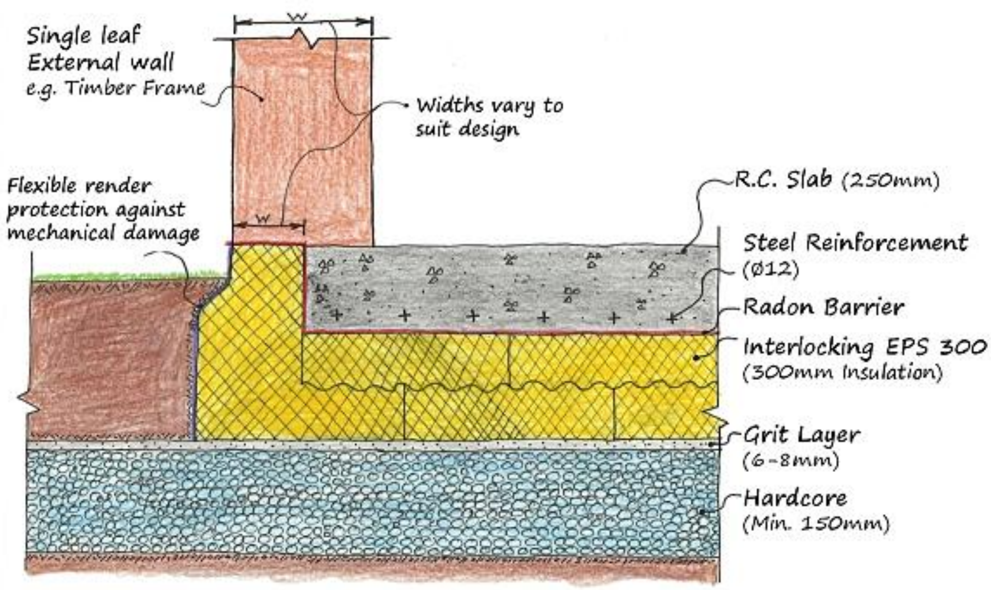
4. ISOQUICK

The ISOQUICK foundation is basically an insulated raft former; it wraps the entire raft foundation in insulation to eliminate any thermal bridges.



The ISOQUICK system was developed in Germany and has been granted Passivhaus approval; as a result it has become very popular in Ireland. Unlike the Viking House or Supergrund System, this doesn't have a perimeter ring beam; instead it relies on an entire 'slab' of high strength EPS 300 throughout. This system is constructed from Peripor (EPS 300 Moulding) modules that join together, resulting in all round insulation; eliminating thermal bridging (ability to achieve a U value up to 0.1 W/m2K) and protecting the structure from moisture.

Below is a simple cross sectional sketch of the ISOQUICK system:



Passive Walls

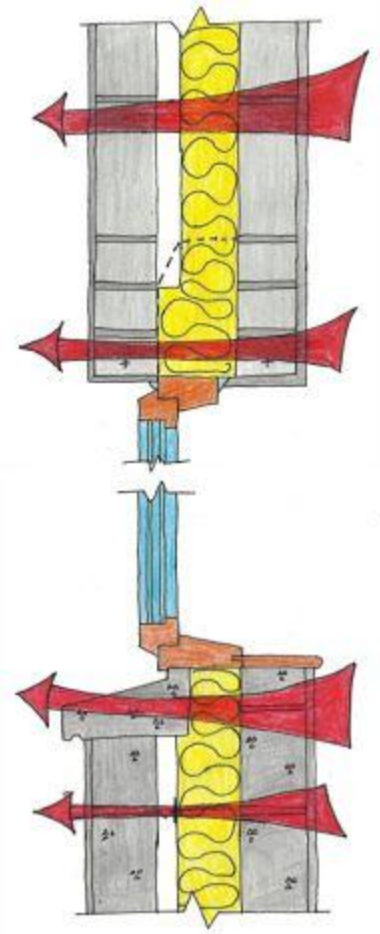
To achieve the passivhaus standard, passive walls need high levels of airtightness and insulation in order to eliminate thermal bridging and achieve the desired U value. The Irish standard for a traditional wall is a U value of 0.21 W/m^2K whilst the Passivhaus standard is between 0.10 – 0.15 W/m^2K.

To gain a deeper understanding of the passivhaus standard it is crucial to examine the difference with regards passive walls and traditional Irish walling systems; for this I have taken the two most common walling systems in Irish construction:

1. **Block Cavity**
2. **Timber Frame**

Block Cavity Walling System

The U value for a block cavity wall is 0.21 W/m²K; this does not satisfy the passivhaus standard.



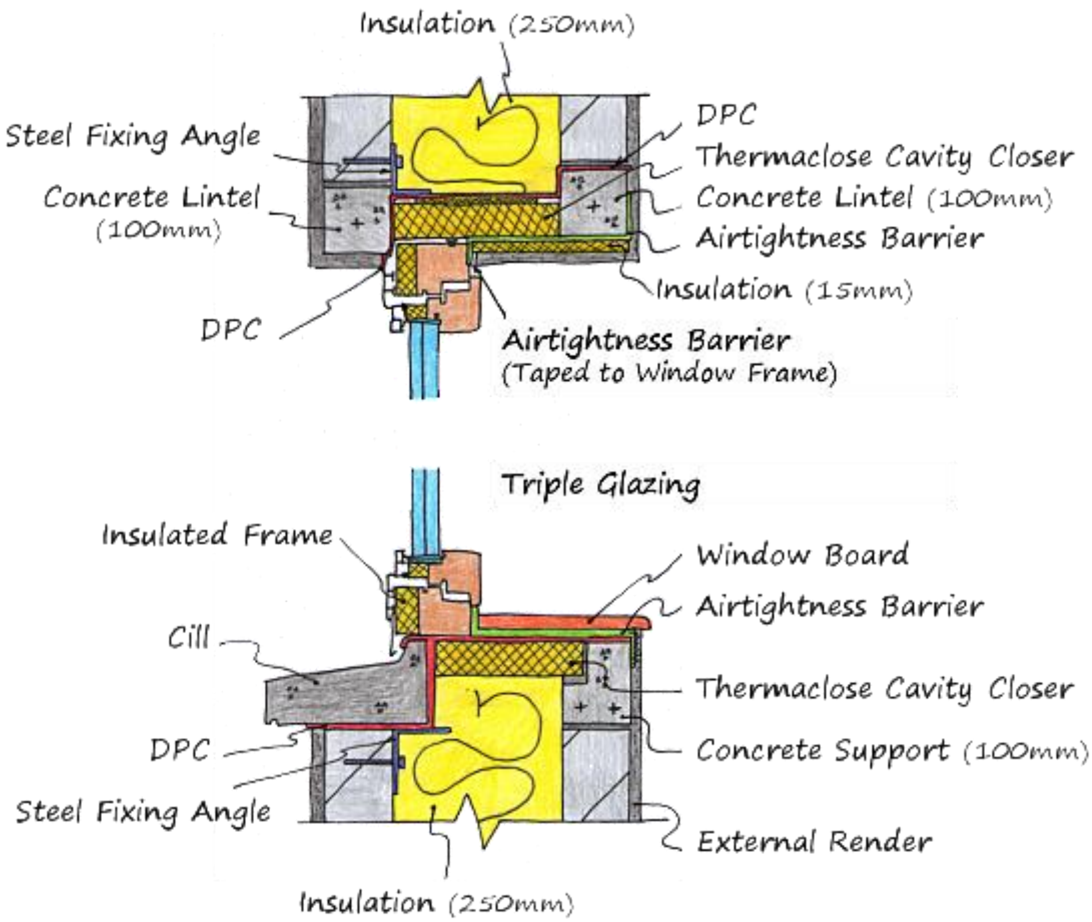
When we examine the block cavity system we can discover flaws in its design; due to the levels of insulation, there is high heat loss through the walls which is not feasible when trying to achieve the passivhaus standard.

Airtightness is also a very important aspect in preventing heat loss; air leakage must be eliminated. The Irish standard for this is 7 $m_3/h.m^2$ at 50 Pa (seven cubic metres of air change per hour for every square metre of floor area when the difference in air pressure between inside and outside is fifty Pascals). This is in comparison with the passivhaus standard of 0.6 $m^3/h.m^2$ highlights the difference in the level of attention to detail and high quality workmanship needed in passive construction.

A key point to understand in block cavity construction is that plaster is airtight. This means once the entire surface area of a wall is covered in plaster there will be no air leakage.

Where airleakage problems arise is at junctions, for example where the window board meets the inner leaf. To prevent air leakage at this junction an airtightness membrane could be taped to the window frame and then continued under the window board and down the inner leaf where it would then be parged; using a steel mesh so that the parging (plaster) will grip.

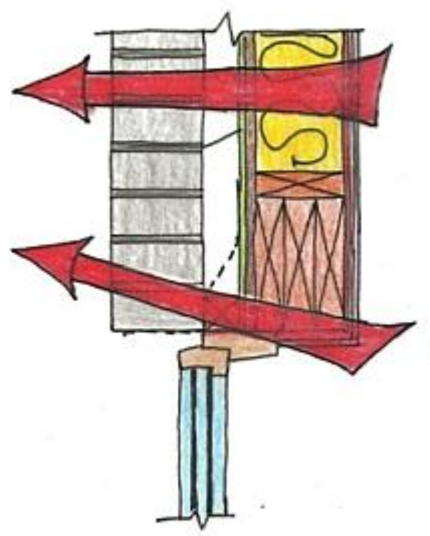
The sketch below is a Passivhaus detail, compliments of integrated energy. In this detail thermal bridges and air leakage which are evident in the traditional Irish block cavity construction are eliminated; this provides the structure with the opportunity to reach the passivhaus standard of between 0.10 - 0.15 W/m²K.



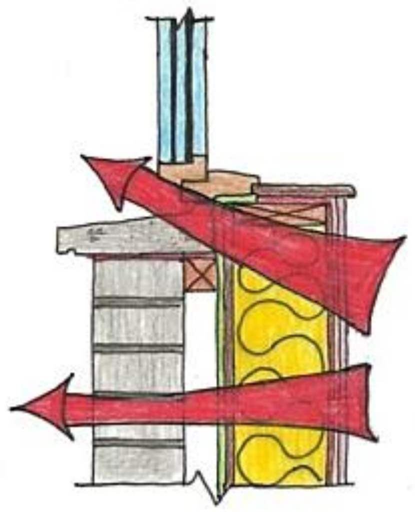
Timber Frame Walling System

The U value for the traditional Irish timber frame wall construction is 0.21 W/m^2K; this does not satisfy the passivhaus standard.

When we examine the timber frame system flaws in its design become evident. One area which needs to be addressed is the level of insulation. As a result of the level of insulation in the walls there is high heat loss which is not feasible when trying to satisfy the passivhaus standard.

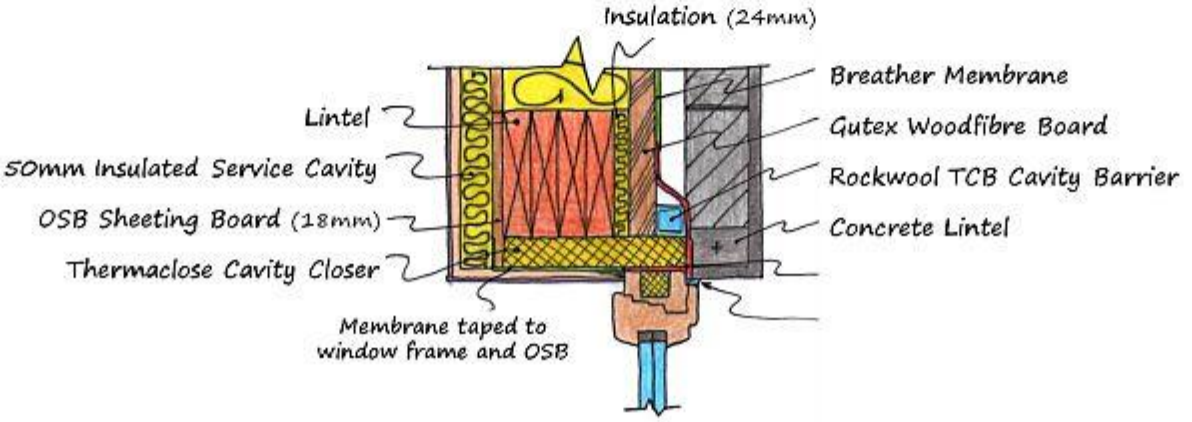


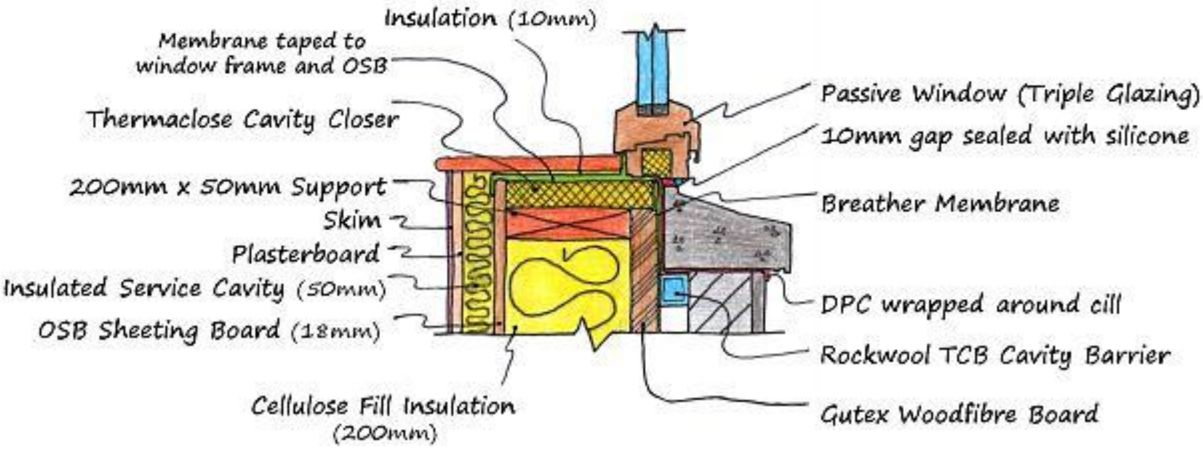
Airtightness is another crucial factor when trying to prevent heat loss through the structure; air leakage must be eliminated.



Timber frame construction is quite challenging to make airtight; when installing the membranes high quality workmanship and attention to detail is crucial; every joint must be carefully taped or sealed (with mastic) to ensure it is airtight. The Irish standard (Part L 2011) for airtightness is 7 $m^3/h.m^2$ at 50 Pa (seven cubic metres of air change per hour for every square metre of floor area when the difference in air pressure between inside and outside is fifty Pascals), this is quite a low level of airtightness when compared to the passivhaus standard of 0.6 $m^3/h.m^2$. This portrays the difference in the level of detailing and quality workmanship needed to achieve the passivhaus standard.

The sketch below is a Passivhaus detail; compliments of Integrated Energy, Crean Salley Architects and Shoalwater Timber Frame. In this detail thermal bridges and air leakage which are evident in the traditional timber frame construction are eliminated; this provides the structure with the opportunity to reach the passivhaus standard of between 0.10 - 0.15 W/m^2K.





Passive Roofs

To achieve the passivhaus standard passive roofs need high levels of insulation, thermal bridges need to be eliminated and the structure itself needs to be airtight. The Irish standard (Part L 2011) for a traditional roof structure is 0.16 W/m^2K; this is very close to the passivhaus standard (0.10 – 0.15 W/m^2K) however it still does satisfy it.

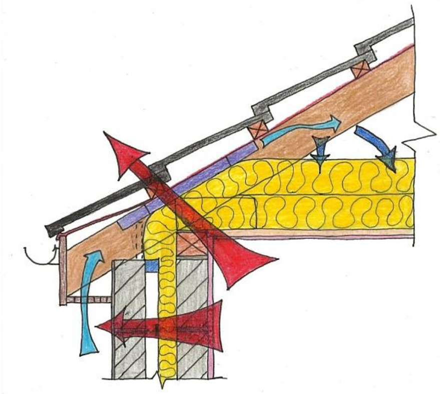
To gain a deeper understanding of the passivhaus standard it is crucial to examine the difference between traditional Irish roof systems and Passive Roofs; again like before I have taken the two most common systems:

1. **Block Cavity**

2. **Timber Frame**

Block Cavity Roof System

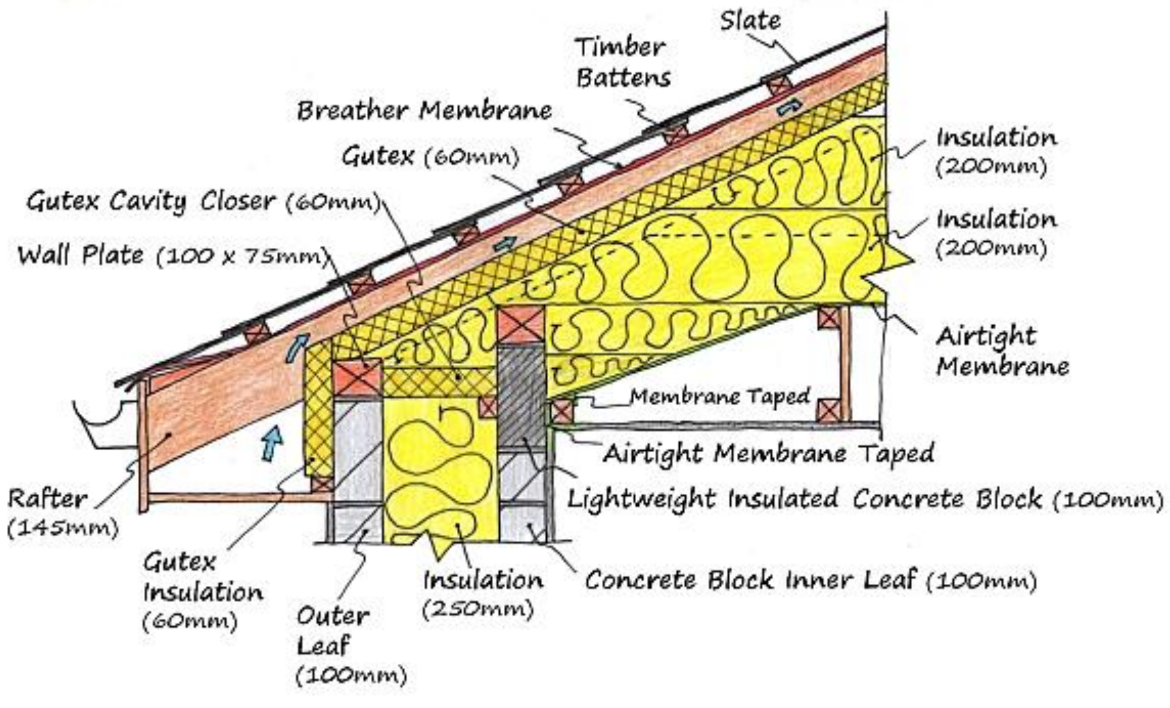
The U value for a traditional block cavity roof system is 0.16 W/m^2K, this is very close to the passivhaus standard of between 0.10 - 0.15 W/m^2K; however it still does not satisfy it.



When we examine the block cavity system we can discover flaws in its design; due to the levels of insulation there is high heat loss through the structure which is not feasible when trying to achieve the passivhaus standard.

With regards airtightness; quite a high level can be achieved by simply parging the walls and ceiling; however there is the risk of airleakage at junctions where differential movement could occur.

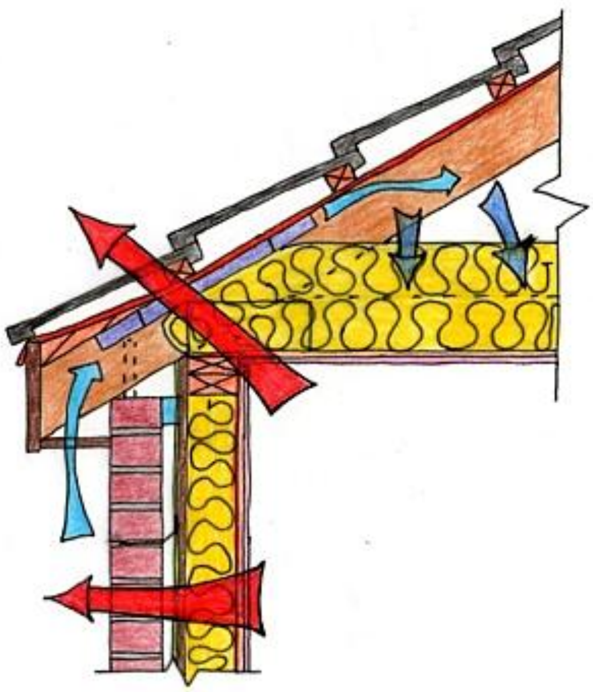
The sketch below is a Passivhaus detail compliments of integrated energy. In this detail thermal bridges and air leakage which are evident in the traditional Irish block cavity roof are eliminated; this provides the structure with the opportunity to reach the passivhaus standard of between 0.10 - 0.15 W/m^2K.



Timber Frame Roof System

The U value for a timber frame roof (Part L 2011) is 0.16 W/m²K; this is very close to the passivhaus standard of between 0.10 - 0.15 W/m²K.

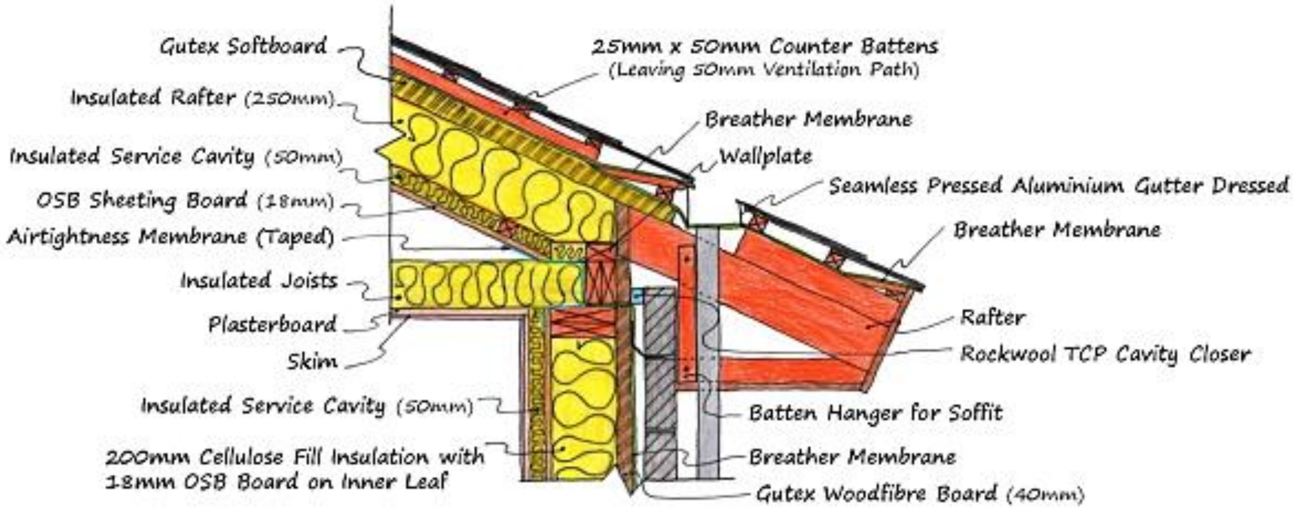
When we examine this detail we can discover heat loss through the structure mainly due to the levels of insulation and the poor level of airtightness.



With regards airtightness timber frame can be quite difficult to make airtight. There are many methods that can be used to make the structure airtight such as use of OSB boards or airtightness membranes however this relies on high quality workmanship and attention to detail; every joint must be carefully taped or sealed (with mastic) to ensure it is airtight.

The Irish standard (Part L 2011) for airtightness is 7 $m^3/h.m^2$ at 50 Pa (seven cubic metres of air change per hour for every square metre of floor area when the difference in air pressure between inside and outside is fifty Pascals), this is quite a low level of airtightness when compared to the passivhaus standard of 0.6 $m^3/h.m^2$. This portrays the difference in the level of detailing and quality workmanship needed to achieve the passivhaus standard.

The sketch on the following page is a Passivhaus detail; compliments of Integrated Energy, Crean Salley Architects and Shoalwater Timber Frame. In this detail thermal bridges and air leakage which are evident in the traditional timber frame construction are eliminated; this provides the structure with the opportunity to reach the passivhaus standard of between 0.10 - 0.15 W/m²K.



Below is the simple sketch of the same system without the labelling to provide you with the opportunity to examine the system in detail.