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1. Background and contact information about your business, organization, or company.

Introduction/Executive Summary

Imagine a building designed from the outset to be deconstructed efficiently and effectively at the end of its life salvaging all of its materials.

Imagine a building where all of its products are renewable materials or abundant in the world and so do not put a strain on existing resources.

Imagine a building where the vast majority of its materials actually take carbon out of the environment and so have negative embodied carbon!

Imagine a building that uses for its primary insulation newspapers that have been left discarded on trains.

Imagine a building that is so well insulated and built that it exceeds by double the demands of the most rigourous energy performance standard of the Passivhaus Institute.

Imagine a building that needs so little heating that if translated to a domestic situation 8 candles would keep a living room at 20 deg C/ 68 Fahrenheit even when it is Freezing outside.

Imagine a building that has been so rigorously thought through in its detail that it is now Ireland's first candidate for assessment under the ultra extreme 'Living Building Challenge 2.0'

Imagine no more - this building has been built and is now being entered as an exemplar building for this years Greendot Awards in the Build Category.

My name is David Hughes. I am Senior Architect for Iarnród Éireann, and I am employed directly by them. I have been an architect for 25 years now, 20 of which have been with Iarnród Éireann as an in house architect.

I am responsible for the overall building design and philosophy. I have held an interest in energy issues ever since my technical dissertation on solar thermal panels in Ireland in 1985 as an undergraduate.

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2. Detailed explanation of the entry

The Entry is for a new Train Drivers Facility Building, in Portlaoise, Ireland.

Portlaoise is the half way point between Dublin and Cork the most important rail route in Ireland.

A 'Drivers Facility Building' is a building linked to where trains are 'stabled' overnight and between shifts. The building operates 24 hours a day 365 days a year and so has a very constant usage demand and is an ideal candidate for the 'passivhaus' building approach of maintaining a 20 deg C interior temperature throughout the year.

The building provides a rest area which is also used for driver training and briefings. In addition there are changing rooms for both male and female drivers. Finally the drivers manager and his administrative assistant both have offices in the building.

So the building is a very typical example of a support building for rail activities and provided a good opportunity to show how an 'ordinary building' could be designed to such exacting standards within a normal budget.

Ireland is the most oil dependent nation in the EU. As energy prices increase and perhaps even more importantly the risks of an supply shock increase, many feel we should not be heating buildings at all and certainly not with oil. Any oil should be kept for uses such as transportation.

So following on from the fact that Ireland's carbon emissions are largely generated in the transportation and the built environment sectors, and having watched documentaries including "An Inconvenient Truth" it seemed to me that there was a real opportunity, not to say imperative, to "kill two birds with the one stone" by designing a state of the art low energy 'transport' building.

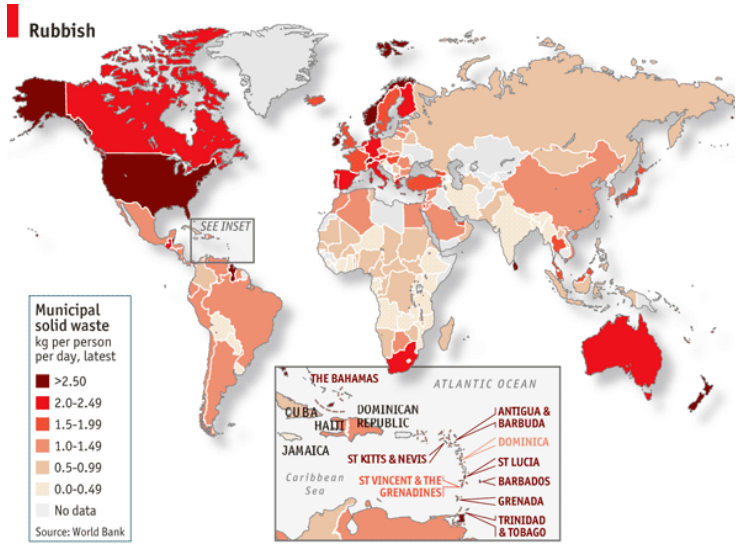
I wanted the building to be an exemplar not only of energy efficiency in use but also in terms of the selectioning and use of materials for its construction and also its eventual deconstruction.

So on that point lets return to the list of invitations to 'imagine' given at the start and see how they were delivered in this building.

DfD or design for deconstruction.
This first point is known as DfD or design for deconstruction. This updates a so called 'cradle to grave analysis' of building materials by considering how easily the materials could be reused at the end of a buildings life. Thus it takes material selection to a new level of 'cradle to cradle' the second cradle being how easily and intact the material remains in its second life/use or 'rebirth'.

The way this building achieved this exacting standard was by doing a root and branch analysis of what makes materials difficult to reuse at the end of a building's life.

Typically concrete for example at the end of its life needs to be broken up and even dynamited so it is not very usable except for a low level use on the 'waste hierarchy' . In this example concrete, after deconstruction, moves down the hierarchy quite significantly from a highly complex ,expensive and energy intensive material to effectively a very low grade fill material if not an outright waste that needs to be disposed of.



http://www.economist.com/blogs/graphicdetail/2012/06/daily-chart-3
This chart shows the amount of waste generated per person per day. In addition In Europe Construction accounts for 4.8 tonnes of mineral extraction per person per annum (2)
DfD reduces demand at both ends of the spectrum.

If building materials can be successfully reused at the end of their life they will reduce pressure on the extraction of new materials and the need to find areas to dump those that effectively become waste. This energy can then also be removed from the life cycle of a building.

Life cycle of buildings accounts for
40% of total global energy (1)

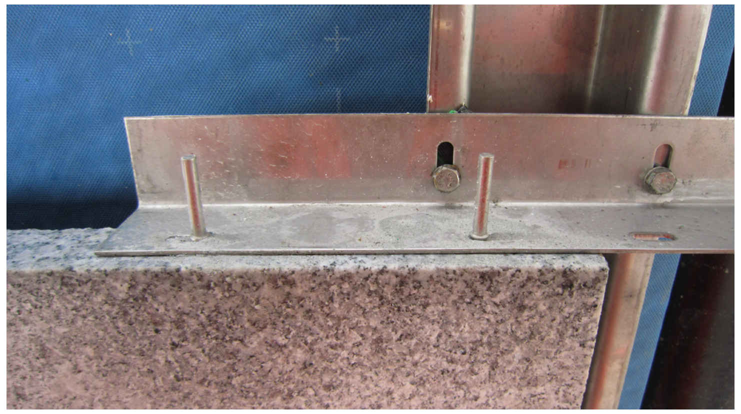
How can this be different? Well examples of materials that are easily reused are materials that can be disassembled in a non destructive way. So structural steel that is bolted together rather than welded is a good example.

View of building underconstruction showing DfD materials including bolted steel frame, bolte fixed main timber studs, screw fixed timber boarding internally and externally and blown in cellulose insulation from recycled newspapers left on trains.

Avoiding using glues and using screws instead is another example. Glues again are a non reversible construction method whereas a screw can be undone and then the individual materials fastened can be released with no destruction.

So with these two examples in mind it is worth setting out how far this building went to allow DfD.

First off its main structural frame is a bolted steel frame.
Attached to this is a twin skin timber carcass made up of uniform lengths and sections of timber.
Screwed to this frame are timber sheets of plywood externally and OSB internally. All modules of the sheeting and the building are based on the standard panel sizes available to reduce waste.
Next the insulation is blow in cellulose or paper insulation.
The fact that it is lose and blown in means it can be vacuumed out at the end of its life and reused in another project.



Detail of dry fixed demountable external cladding system for external stone cladding.

Finally the external stone finish used on the building consists of uniform sized stone panels hung on a self supporting structural system tied back into the main structural frame.
All stone panels are dry mounted and do not need any form of sealant or grout again adding to the reusability of the stone.

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These are but a few examples of how the design and detailing of the building has been considered from a DfD point of view. However it should be borne in mind that DfD has a relevance even in a buildings intended primary life cycle. This is because if a building has been designed from a DfD point of view it is easier to maintain and to access and replace any materials that may need to be changed due to unintentional damage. So often building owners at home or in their work know how difficult it can be to have building work done and how disruptive it is, designing with DfD in mind allows for easier maintenance and replacement and thus provides a win win in a buildings life and at the end of its life by providing high quality materials that do not cascade down the 'waste hierarchy' but maintaining their usefulness and their value minimising the demand on resources for materials in the building industry as a whole.

Renewable or Abundant Materials.
The second point follows on from the last and deals with renewable and or abundant materials. Renewable materials are generally understood and the best example is timber from well managed forests. Abundant materials are materials that are so widely available that they don't put a strain on any natural resources. The best example in this building is the granite stone cladding. Granite is the most abundant stone in the world and 70% of all stone in the world is granite. This means there is a plentiful supply of this material. In addition granite's geological characteristics means it is a very durable material and in effect does not have a limit on its design life. So as will be seen both types of materials are used through out this building and so again the building's design illustrates how a contemporary building can be made without placing any strain on the world's resources.

Carbon Sequestration.
Embodied energy and carbon in materials is a relatively new concept in sustainable building. Both try to measure the amount of energy and carbon that go into producing a building material. Well like so many areas of research it throws up some surprising results. In this case the result is that timber products are carbon and energy negative in terms of embodied values! This is because as a tree grows it absorbs carbon dioxide from the environment. So not only is the use of timber a healthy and natural alternative to many synthetic materials but it actually removes carbon dioxide from the atmosphere while growing.

FSC certified timber used on project.– One Kilogram of dried timber can contain1.8 Kilograms of C02eq/kg stored as Carbon or a negative Global Warming Potential (GWP) □1.8 KgC02eq/kg (5)

So while this building is clad in natural granite and has a structural steel skeleton 95% of its construction volume is timber or a timber derivative products.

Recycled Newspapers.
Naturally I travel often on the train. One day I noticed a newspaper left on virtually every seat or table as we all got off the train. Many of these are so called free newspapers given out to commuters. I was looking for the best material to insulate the building with and seeing the newspapers was a real Eureka moment. I contacted Excel Industries in Wales who manufacture the insulation and put them in touch with the publishers of the newspaper. The upshot was that this building is entirely insulated in recycled newspaper and thus converts a potential waste source into a high value product moving it up the 'waste hierarchy. In addition as newsprint is a wood by product there is also negative GWP and embodied carbon. In fact a study was done that shows for a typical house built of timber and derivative products that the amount of carbon saved is equivalent to heating that house for 25 years.

Exceeding Passivhaus Standards.

This building is a certified Passivhaus. In fact it is the first Passivhaus for any Railroad company worldwide and the first commercial passivhaus for the Irish State. This reason alone may have made it a worthy candidate for entering for a Greendot Award. However not only does this building achieve the passivhaus standard but it exceeds many of the standards two fold. For example
Walls Passivhaus Standard (PHS) 0.15W/m^{2}K
Achieved 0.07W/m^{2}K 50% less
Airtightness PHS 0.6 Air changes at 50 Pascals
Achieved 0.3 0.6 Air changes at 50 Pascals 50% less
Maximum Heat Load PHS 15W/m^2
Achieved 12W/m^2 some 20% less.

8 Candles will heat a typical living room to 20C/68F

8 Candles alone will heat a living room to 20 deg C.
To really illustrate this simply the heat load of this building is 12W. The maximum allowed by the Passivhaus Institute is 15W/m^2. A typical candle emits 30W of heat energy. A typical Living room is about 20m^2 (220 sq ft). This means even when freezing outside the heat off 8 candles or 240 W will keep the room at 20 degrees Celsius. No other form of heating would be required!

Living Building Challenge

http://living-future.org/lbc

The Living Building Challenge is the most radical and far reaching environmental rating systems for buildings yet. It seeks to move away from the notion of a building simply being 'sustainable' to one that is restorative and even regenerative. Taking the analogy of planting a flower or a tree it challenges all building designers to consider the impact their building will have in a holistic way.

This building is the first candidate for assessment in Ireland. A building has to be in use for at least one year before being eligible for assessment. This building was completed in August 2011 and is now eligible for assessment.

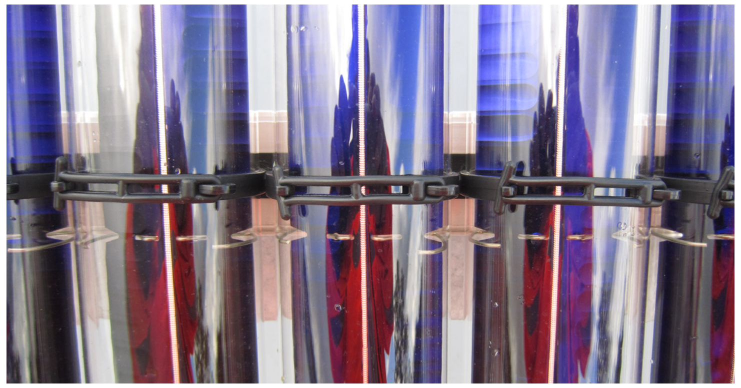
In addition to the many reasons given already for why the building should be eligible for the LBC further ones included

70% of hot water the single largest energy demand for the building is provided by solar thermal panels
50% of the buildings cold water is provided by rain water
There are no VOC paints used in the building and in fact the paint that is used is knows as 'Freshair paint' and actually takes out any free floating radicals from the air in the building.
Floor finishes are linseed oil based i.e. linoleum
Natural Linseed oil was used to treat exposed timbers.

Building Physics.
To achieve these ultra low values building physics played a key role. **Therm and WUFI** software were key design tools. If you have time please read the article overleaf and **especially** this one online http://architectureanddesign.marmomacc.com/veronaMarmorea_n12b.asp

Conclusion.

Ultimately I believe that the emphasis on low energy and low carbon design will be the single biggest influence in bringing about a new discipline architecture, an architecture where form follows nature and makes the best uses of all of the available natural renewable resources.
As the construction sector in Ireland suffers its worst recession in living memory the onus is on government or state companies to champion exemplar buildings so that the skills and knowledge move into the wider construction sector. This means when construction returns to normal levels these principles and practices will be tried and tested and will be ready to be rolled out on large volume projects as well.



Detail of Solar Thermal Collector

Solar Thermal Collector provides 70% of annual hot water

Open Jointed Demountable Granite Cladding ideal for DfD

Demountable Fixing System bolted to Structural Steel Frame

Building separated from cold by thermally broken columns

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The Following is an article on the building that was published in Construct Ireland in 2011. Construct Ireland is the premier magazine for low energy and sustainable buildings. I think this article gives a good succinct overview of the building and I am reproducing it here with a link to the original also in the list of links for the building at the end of this document.

Built on stilts, entirely encased in recycled newspaper insulation on all sides, and designed to be easily taken apart so that its constituent elements can be reused once it reaches its end of life, Portlaoise Locomotive Drivers Building could hardly be more green. But it is – it's a certified passive house. Iarnród Éireann senior architect David Hughes explains how such a sustainable exemplar came to be.

Train travel is the most sustainable form of vehicular transport. When a project came up to provide new accommodation for the very drivers of the greenest form of transport, it seemed a natural choice to design the building to the highest standards of energy efficiency and sustainability. The passive house standard was chosen as the low energy approach, making this the first passive house building for any railway company in the world. In achieving this, Iarnród Éireann is showing leadership and commitment to up skilling all who contribute to the procurement of cutting edge low energy and sustainable buildings, ensuring that these skills find a place in the Irish construction industry as a whole. The design was produced by Iarnród Éireann's own architecture and structures section. Designing in house ensures that the experience gained in completing this building can be leveraged into other projects in the future, thus building on each experience from one project to the next.

Building programme

The building's programme and 24 hour use pattern suited the passive house concept particularly well. The building is 200 square metres and consists of changing rooms with showers, toilets, a manager's office, an administrative office and a large open plan driver's rest area. It was felt that a passive house building would provide a high degree of comfort and a very healthy environment for the drivers.

Sustainability

Iarnród Éireann have been looking at a number of ultra low energy designs since 2006. In exploring the issues of sustainable design it was clear that targets like zero energy and zero carbon in terms of the building's operation was becoming more achievable. But truly sustainable design encompasses more than just the energy used by the finished building, taking in the energy and carbon embodied in the materials themselves, and ideally designing for deconstruction, so that when the building reaches its end of life its constituent parts can be salvaged and resold, replacing a disposal cost with a saleable asset.

Design for Deconstruction (DfD)

DfD was actively considered in the detailing of this building. For instance the granite is treated as an open jointed rainscreen hung off an independent demountable support system bolted to the steel structural frame, the steel frame itself uses bolted connections for the majority of connections, secondary and tertiary timbers are bolted or screwed instead of glued. DfD, apart from ensuring that at the end of its life most of the materials will be recoverable, will also allow the building to be easily extended should the number of drivers increase.

Architectural design

The architectural design for this building was deliberately minimal. Just as the passive house concept emphasises passive (in other words hidden) principles first, so this building does not wear its green credentials on its sleeve. Instead the building's architecture combines all of these ideas into its design and particularly its detailed construction which had to go back to first principles to draw these different strands together.

Learning curve

The architects section led by the author and technologist David Abbey embarked upon a concerted effort to acquire all of the skills necessary to holistically understand low energy design and detailing. This included the passive house training (Passivhaus Institute Germany), airtightness design (SIGA Switzerland), thermal bridge analysis using Therm (Lawrence Berkeley National Laboratories USA) and hygrothermal analysis using WUFI (Fraunhofer Institute of Building Physics Germany and Oak Ridge National Laboratories USA). A thorough understanding of building physics principles is needed by architects as it has been consistently shown that most energy savings are made by getting the principle right at sketch design stage. If architects don't feel well versed in these areas then key design decisions will be missed until it is too late. Crucially, the Passive House Planning Package (PHPP) software provided very early indicators of the designs performance at sketch design stage, which allowed for all of the iteration to occur during this process – and not at a more advanced and hence costly stage following planning or even tender. In practice for this particular building, it meant most of the key decisions were made and validated before IN2, the project's M&E engineers, were in place. This was IN2's first passive house building but as there were no significant changes from sketch to detailed design, they were free to concentrate on the detailed design of M&E services without the need for abortive reworking of the design itself.

Materials and construction

The materials used for the building were deliberately sourced from sustainable sources including waste streams such as discarded newspapers. In the early stages of the design the building was assessed against the USGBC LEED (Leadership in Energy and Environmental Design) new build standard. This was a useful checklist and highlighted some unusual facts such as the relatively good rating of steel as a material. While intuitively steel may not be thought of as a sustainable material, LEED points out that steel typically includes high percentages of recycled steel and, as is the case here where all of the main connections are bolted, it can be successfully recycled and reused at the end of its life. For this reason steel was used for the main structural frame of the building. Although the building is steel framed and clad with a natural granite rain screen, it is essentially a timber building by volume. Timber was chosen because of the ease of working the material on site and because of its low embodied energy and carbon characteristics, as well as good thermal properties. All timber products used are FSC certified. Sheet timber and structural timber sections for roof joists, floor joists and wall studs are used to form a closed carcass. The fact that the building is on stilts allowed the detailing to be very similar for the roof, walls and suspended floor. In concept this build up acts as a sort of permanent formwork for containing the cellulose insulation – which is up to 585 mm deep to achieve the low U values necessary.

Sustainable and renewable and recycled resources

As stated at the outset, this building sought to go beyond passive house design by looking at renewable and sustainable technologies and materials to achieve the finished building. For instance cellulose insulation was chosen as a way of creating a use for discarded newspapers so often seen lying on trains. In addition the properties of the material could be used to ensure that every nook and cranny was filled with insulation – something which would be much more tedious and difficult to do with other forms of insulation. The largest demand of energy for the building is hot water for the changing room showers. This high thermal energy demand was met by providing a Kingspan Thermomax evacuated tube solar thermal array. The remaining energy demands are all electrical for lighting, small power and motive power, including running the Drexel & Weiss Aerosmart L compact unit which heats the building via the ventilation system. Toilet flushing is the building's largest demand for water. The building employs a rainwater harvesting system to ensure that another finite resource is used appropriately with the added benefits of reduced water rates for consumption and disposal via the local authority infrastructure.

PROJECT OVERVIEW:

Building type: 228 square metre single storey accommodation building for Iarnród Éireann locomotive drivers Location: Iarnród Éireann Train Car Depot, Portlaoise, Co Laois Completion date: August 2011 Passive house certification: certified Space heating demand (PHPP): 12 kWh/m2/year Heat load (PHPP): 12 W/m2 Airtightness: 0.31 air changes per hour at 50 pascals pressure

The full article can be viewed at http://www.constructireland.ie/Vol-5-Issue-8/Articles/Design-Approaches/Train-drivers-building-gets-sustainability-on-track.html

Portlaoise Train Drivers' Building

WARMCEL® Project Overview

WARMCEL helps Iarnród Éireann go 'beyond passive house' design

PROJECT DETAILS

Installer: McHugh Insulation

Contractor: Conneely Builders

Client: Iarnród Éireann (Irish Rail)

Overview

It makes sense that the rail industry – purveyor of the most environmentally-friendly form of vehicular transport on the planet – should also look for sustainability in its building projects. However, thanks in part to the use of WARMCEL insulation, Irish rail network provider Iarnród Éireann has gone beyond expectations for its latest construction: a train drivers' rest building in Portlaoise.

In fact, the company has even decided that the 'Passive House' standard doesn't go far enough, so as well as a sustainable lifespan, the new structure has been built with the environment in mind from the moment its materials were chosen, right through to when it may be eventually demolished.

Project

WARMCEL insulation was selected for this project (alongside a host of other green technologies) as it is manufactured from recycled newsprint and has a Global Warming Potential of -1.9, actually lowering the structure's carbon footprint. It also enables airtight installation, preventing energy from easily escaping the building and helping the structure achieve Passive House certification (especially relevant given the building's 24 hour usage pattern and the need to provide a comfortable and healthy environment for drivers between working shifts).

The 200m2 building comprises changing rooms, showers, offices and an open-plan rest area, and its stilted structure enables complete void fill of insulation enveloping the whole building. All elements have been installed with eventual decommissioning in mind, including WARMCEL which is 100% reusable and recyclable. The steel and timber-framed structure was designed on the principal that it is vital to set out environmental specifications from the outset, and ensure that they are followed closely during construction.

"WARMCEL was specified as it can ensure that every nook and cranny is filled," explained David Hughes, project architect, "something which would be much more tedious and difficult to do with other forms of insulation."

EXCEL Fibre Technology

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Email: tech@excelfibre.com Web: www.excelfibre.com
Registered in England No.2072145

Brochure produced on building by insulation manufactures.

Breathe again and feel well – with Auro Airfresh wallpaint

The main purpose of a wallpaint is to beautify rooms. A new generation of wallpaint offers much more than the visual advantages of a fresh coat of paint. AURO Airfresh wallpaint combines a pure white surface with the permanent degradation of pollutants, smells and germs. Thus a pleasant room climate is maintained.

How does it work?

The special raw material combination of AURO Airfresh wallpaint makes the product work like a biocatalyst that, with the help of light, splits up air pollutants into neutral substances. The best effects are achieved in rooms that have daylight but it also works under the influence of artificial light.

The process of degradation does not decrease, the effectiveness remains constant until the coat has to be renewed. Just like every room, also rooms painted with AURO Airfresh wallpaint should be regularly ventilated. Movement of the air is necessary to transport the pollutants in the direction of the wall where they can get in touch with the wall paint and can be degraded.

1 2

Thick air

There are many things that can lead to 'thick air' within rooms. AURO Airfresh wallpaint permanently neutralizes the odours coming from smoke or cooking, and evaporations from furniture or carpets. Moreover, pollutants (e.g. organic compounds) and microorganisms like bacteria are degraded.

AURO Airfresh wallpaint is the only wallpaint with a photocatalytic effect that works on the basis of consistently ecological raw materials, without the inclusion of any acrylics or other petrochemicals.

Examined quality

Scientists of the Institute of Technical Chemistry in Hanover have carried out exemplary tests and confirmed the photocatalytic effect of AURO Airfresh wallpaint.

Easy application

AURO Airfresh wallpaint is a low-odour, solvent-free, white wallpaint. Due to its alcalinity, it also has an inhibiting effect on microorganisms like mould spores, viruses and bacteria. It can be applied by roll or brush. The product has a good yield, up to 100 m² can be painted with 10,0 L.

If you prefer a coloured paint coat to the pure white the Airfresh wallpaint can be tinted in pastel tones with AURO Lime-casein coloured paints No. 770. The pigmentation will, however, slightly diminish the photocatalytic effect. AURO Airfresh wallpaint can be painted over old paint coats. A reworking of a surface painted with Airfresh wallpaint should be carried out with the same product although other AURO wallpaints can also be used for renovation. In any case, a sample coating on a small spot is recommended to test product compatibility.

Improved quality of life

AURO Airfresh wallpaint cares for permanently fresh room air and is especially valuable where a room is subject to extraordinary charges, e.g. schools, conference rooms, hotels, restaurants, but also in living rooms, bedrooms, nurseries, kitchens ...

Airfresh wallpaint helps you to create rooms to feel good in.

AURO Airfresh wallpaint is available in 10,0 L (for approx. 100 m² per coat) or 5,0 L (for approx. 50 m² per coat).

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Links to other published articles on the building to date

Ireland
http://www.irishtimes.com/newspaper/property/2012/1018/1224325392760.html

Belgium
http://www.bepassive.be/viewer/12/fr/
see page 92

Ireland and Austria
http://www.advantageaustria.org/ie/oesterreich-in-ireland/news/local/20111017-Double-first-for-Irish-Rail-with-to-two-key-.en.html

Germany
http://passiv.de/downloads/05_16pht_index_en.pdf
http://passipedia.passiv.de/passipedia_en/phi_publications/international_passive_house_conference_contributions

USA
http://digital.bnpmedia.com/publication/?i=105430

Italy and USA
http://architectureanddesign.marmomacc.com/veronaMarmorea_n12b.asp

This article gives key data on the building physics of the external wall construction summarised in the panel to the right.

Photograph Showing deep solar control overhang

Photograph Showing stone floor used as a heat sink to soak up sun's energy in winter.

Photograph Showing Restrained Minimal Aesthetic overall

Building Physics and Simulation's Role in cutting edge design.

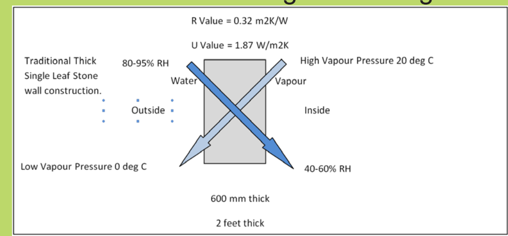
When one considers how long humans have been building and how recently insulation has been added to buildings it is a very very recent addition indeed.

However as the pursuit of low to zero energy design becomes mainstream building physics and simulation will become paramount in developing new solutions to what were very traditional and commonplace details.

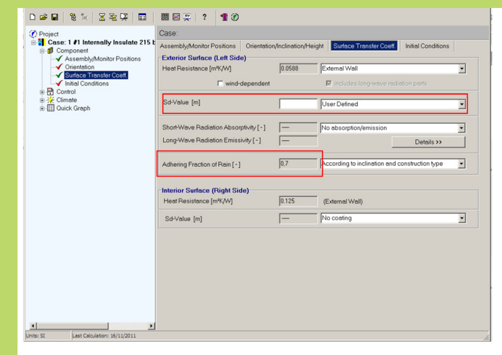
In this building it is worth comparing a traditional load bearing stone wall with the wall buildup in theTrain drivers building.

To achieve a U value of 0.07 W/m²K over 95% of a traditional wall's thickness needed to be insulation. To arrive at this detail building simulation software WUFI from the Fraunhofer Institute of Building Physics was used to run 'what if' simulations to ensure that the building's wall and other key details would work correctly in the host climate.

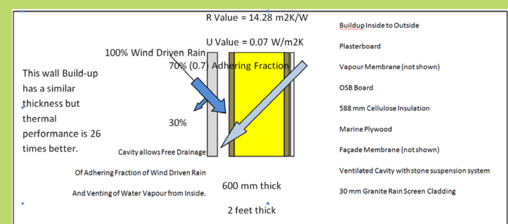
Therm from the Lawrence Berkeley National Laboratories was used to study and eliminate any thermal bridges which are in effect short circuits through a building's insulation.



In simulation traditional walls were seen to carry water vapor from inside to outside and liquid water (rain) from outside to inside. This has to be allowed for in the new wall



Building Simulation showed that 70% of rain adheres to a facade. This is a very high amount of liquid moisture.



Building Physics and Simulation allowed us to develop the detail of a 'stone shield' stopping 70% of adhering rain externally and allowing 95% of overall thickness to become an insulating layer helping us achieve U values that are less than half the maximum permitted by the Passivhaus Institute in Germany but still allowing vapor out.

Useful References including citations from text.

(1) Dixit, M.K. et al., 2010. Identification of parameters for embodied energy measurement:
A literature review. Energy and Buildings, 42(8), 1238□1274.

(2) Bribian, I.Z., Capilla, A.V. & Uson, A.A., 2008. Life cycle assessment of building materials:
Comparative analysis of energy and environmental impacts and evaluation of the ecoefficiency
improvement potential. Building and Environment, 40(5), 837□848.

(3) Gardner, G. & Sampat, P., 1998. Worldwatch paper 144: Mind over Matter: Recasting the
role of Materials in Our Lives. Available at: www.worldwatch.org/system/files/EWP144.pdf

(4) ISO, 2006. BS EN ISO 14044:2006 Environmental management □Life cycle assessment □
Requirements and guidelines.

(5) Berge, B., 2009. The Ecology of Building Materials, Oxford: Elsevier.

(6) Waltjen, T. et al., 2009. IBO Austrian Institute for Healthy and Ecological Building: Details
for passive house□a catalogue of ecologically rated constructions, Vienna:
SpringerWienNewYork.

(7) ISO, 2010. BS EN ISO 14025: 2010 Environmental labels and declarations □ Type III
environmental declarations and procedures.

(8) Hammond, G. & Jones, C., 2008. Embodied energy and carbon in construction materials.
Energy, 161(EN2), 87□98.

(9) McInerney, M. 2011
Comparative Study of Building Materials and Embodied Energy & Global Warming Potential in Low Energy Passive House Buildings.


OSB timber sheeting sealed with airtight tape.


Detail of Thermally broken Steel Frame


Fixing point from strutcural frame to exterior.


Steel Frame and Stone clad but 95% wood products!


Internal Vapor Membrane on external walls.

'Fresh Air Paint' used internally on all surfaces.

Heat and Air handling:Energy use less than a toaster!

Rainwater provides 50% of buildings water needs


DfD Stone panels as delivered to site.


DdD steel cleats with pre drilled bolt holes.


Plywood Sheeting screwfixed to timber roof joists


Steel Frame and Stone clad but 95% wood products!