2 TECHNICAL FACTSHEET
Choice of Materials

Hockerton Housing Project
Bringing sustainability to life

Summary

The **Hockerton Housing Project (HHP)** is an innovative residential sustainable development. It was designed as the first zero energy residential site in the UK, reducing life cycle energy to a minimum. The houses are earth covered and have passive solar heating without a space heating system.

Maximum use of benign, organic and recycled materials has been made in the construction and the development is designed to be autonomous. A wind turbine and photovoltaic system provide all of the electrical energy required to run the homes. The water and sewage system is self-contained.

Design

Size

Each house is 6 m deep with a 19 m south-facing conservatory running the full width of each dwelling. A repeated modular bay system of 3m in width was used for ease of construction. Most of the internal rooms have 3.3m high French windows that open to the conservatory. Four of the houses are of six bays and have 108m^2 net internal floor area (114m^2 gross) and 48m^2 of conservatory area. The centre house is of seven bays and has 126m^2 plus 57m^2 of conservatory. Both sizes of houses have a porch with a floor area of 8.1m^2.

Large south-facing conservatory over-looking lake

View from roof of homes

Key design objectives regarding energy performance and sustainability

- Reduction of space heating requirement by artificial means to zero.
- Reduction of CO_2 emissions incurred by the existence of the development to zero.
- To be as autonomous as possible in terms of provision of utilities, including water.
- To use renewable energy sources to meet the energy requirements of the development.
- The use of easily transferable construction techniques and ready available, environmentally responsible materials.
- Competitive costing to conventional housing in the short term with demonstrable savings over conventional housing in the medium to long term.
- Occupier control of infrastructure and services with minimal maintenance.
- Increased biodiversity and enhanced landscape associated with the project.
- Compensation of CO_2 emissions arising from construction work and embodied in materials.
- To achieve all of the above with no loss of comfort or modern amenities.

Criteria for choice of materials

(See also Appendix 1)

The materials used were selected from criteria which included technical & physical properties, suitability for the aims of the scheme, processes by which they are made and environmental and energy considerations. The criteria were:

- Minimal energy created by manufacture and supply to site ('Embodied Energy') in addition to minimal long-term energy requirement of homes ('Operational Energy')
- Physical properties included structural integrity (to support heavy-weight construction and earth-covering) and high thermal performance (to eliminate need for dedicated space heating)
- Simplicity (e.g. the single storey modular layout of the plan with repeating units allowed for constant spans and economies of scale for fitments such as doors and windows.
- Readily available ('off-the-shelf materials') products wherever possible
- Low to medium technology materials
- Local supplies where possible (reduce embodied energy)
- Longevity including long term reliability
- Low maintenance
- Minimal impact on land and resources (replace green footprint/ enhance local environment)
- Environmental policies of the manufacturers. Every effort was made to use natural, traditional materials.
- Toxicity of raw materials and of final products in terms of environmental and health hazards

Construction

Summary

(See Architect's drawing on opposite page and graphic on p.4)

The development is of **high thermal mass** construction having 200 mm concrete block internal cross walls on a 300 mm concrete slab, with a concrete beam-and-block roof. The 500mm thick rear & side walls are two skins of concrete blockwork used as formwork to contain concrete. The adoption of a single sub-slab (or blinding slab), 150mm in thickness, simplified the construction of the superstructure. There are no movement joints. A polythene waterproof geomembrane was laid on the upper blinding slab and then round the whole building.

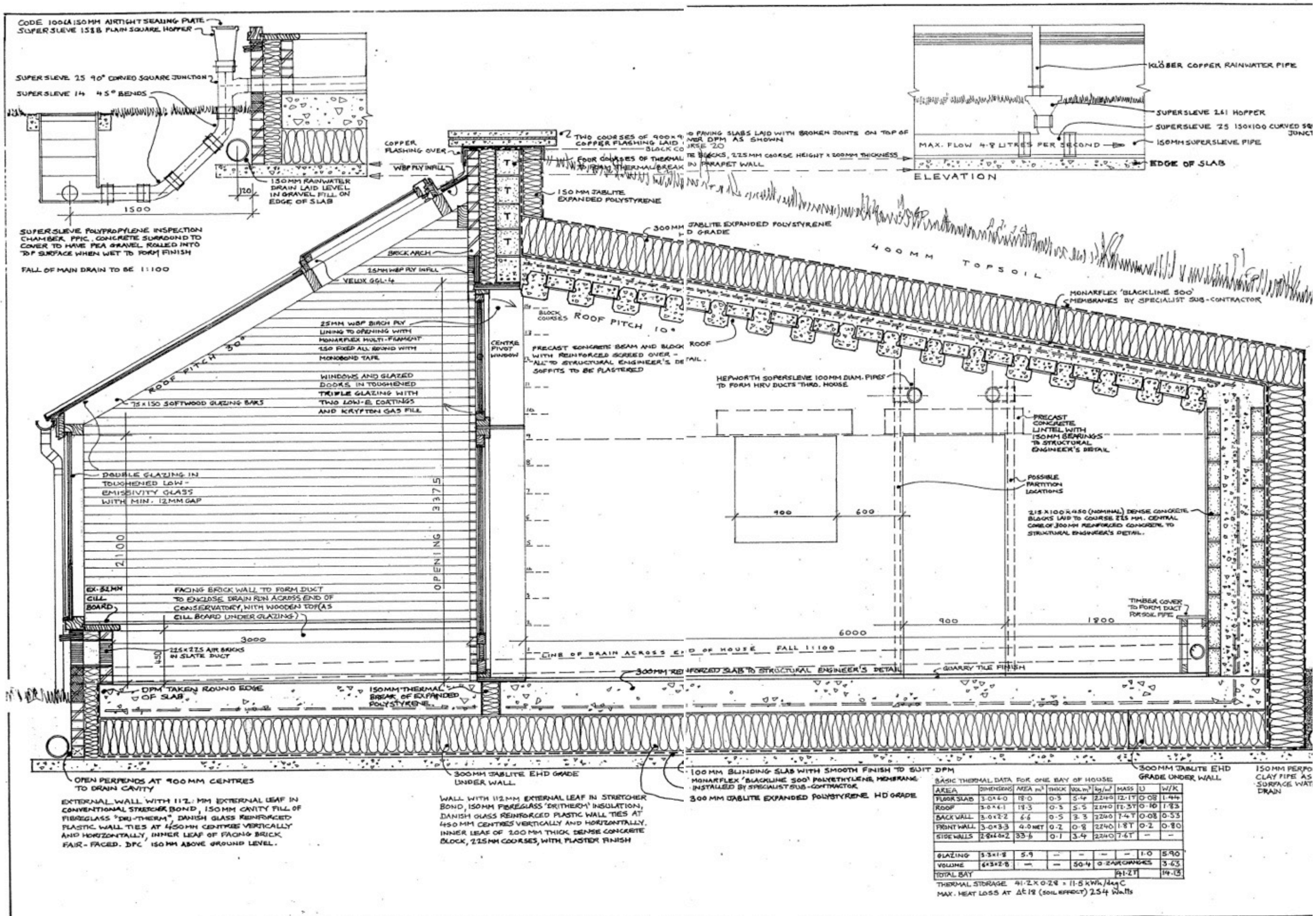
Rear & side walls, slab and roof are **super-insulated** with 300 mm of expanded polystyrene (cfc free) with the insulation on the outside of the mass. The front wall has 150mm of Dritherm insulation. The roof is covered with 400 mm of topsoil. The north side and terrace ends are sheltered with soil. The exposed front wall is clay brick, using bricks fired from waste methane gas. All of the internal walls are wet plastered. There are no holes through the main slab for soil pipes or services so the insulation and membranes are not perforated.

The main doors and windows opening into the conservatory are triple glazed with low-e glass (Pilkington K glass) and argon gas filling, whilst the conservatory has double low-e glazing.

The roof, walls and floor have a U-value of approx 0.1 W/m^2K and the triple glazed units 1.1.

End wall construction showing different layers of materials used

Soil being placed on roof and returning green footprint, to be used in future years for sheep grazing



BASIC THERMAL DATA FOR ONE BAY OF HOUSE

AREA	DIMENSIONS	AREA m²	THICK	VOL m³	kg/m³	MASS	U	W/K
FLOOR SLAB	3.0×6.0	18.0	0.3	5.4	2240	12.1T	0.08	1.44
ROOF	3.0×6.1	18.3	0.3	5.5	2240	12.3T	0.10	1.83
BACK WALL	3.0×2.2	6.6	0.5	3.3	2240	7.4T	0.08	0.53
FRONT WALL	3.0×3.3	4.0 NET	0.2	0.8	2240	1.8T	0.2	0.80
SIDE WALLS	2.8×6.0×2	33.6	0.1	3.4	2240	7.6T	–	–
GLAZING	3.3×1.8	5.9	–	–	–	–	1.0	5.90
VOLUME	6×3×2.8	–	–	50.4	0.2 AIR CHANGES			3.63
TOTAL BAY						41.2T		14.13

THERMAL STORAGE 41.2 × 0.28 = 11.5 kWh/degC
MAX. HEAT LOSS AT Δt 18 (SOIL EFFECT) 254 Watts

SUSTAINABLE SETTLEMENT AT HOCKERTON ▫ NOTTS ▫▫ TYPICAL SECTION ▫ SCALE 1:20 ▫▫ BRENDA & ROBERT VALE ▫ CHARTERED ARCHITECTS ▫▫ 16 JULY ▫ 19...

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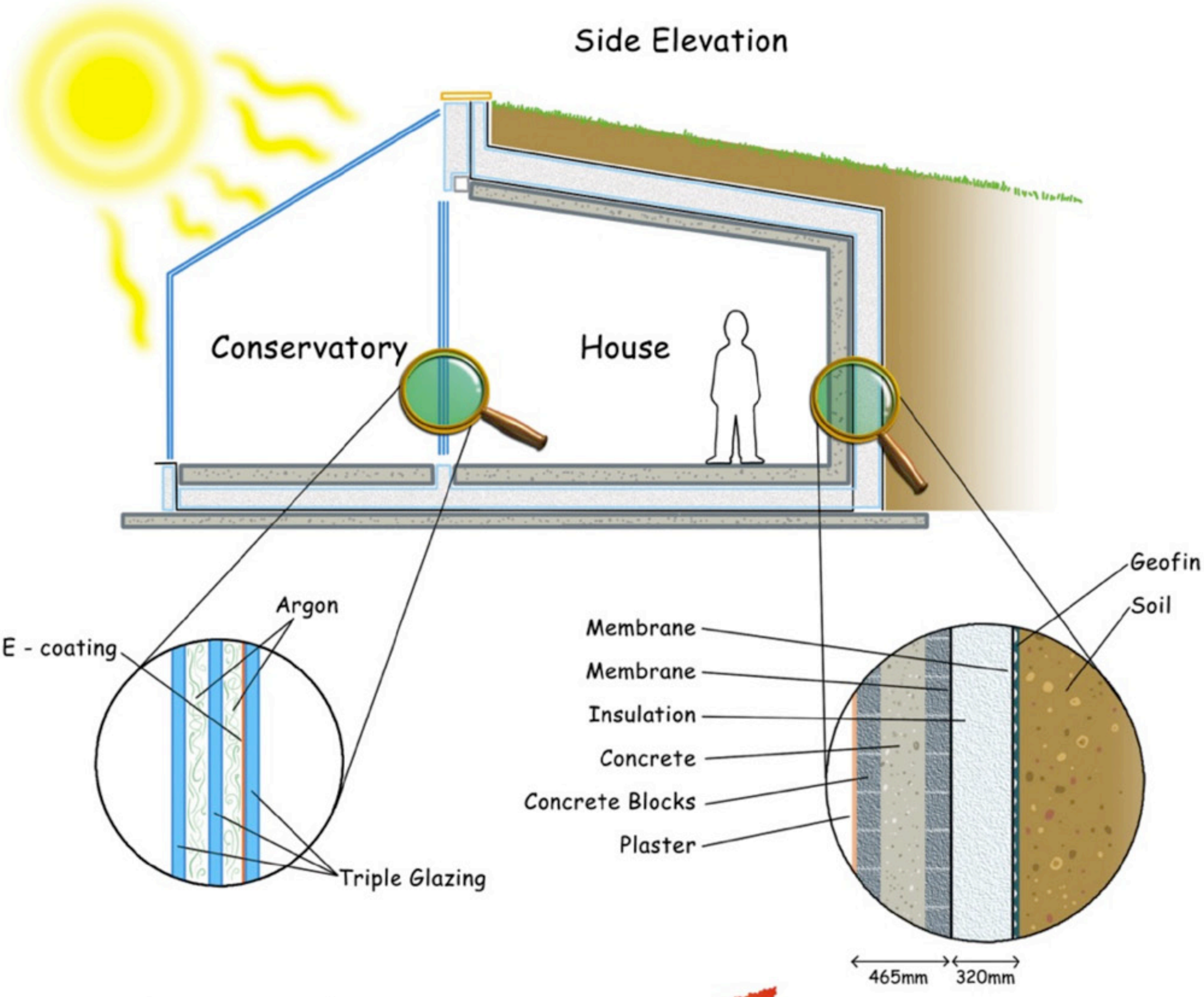
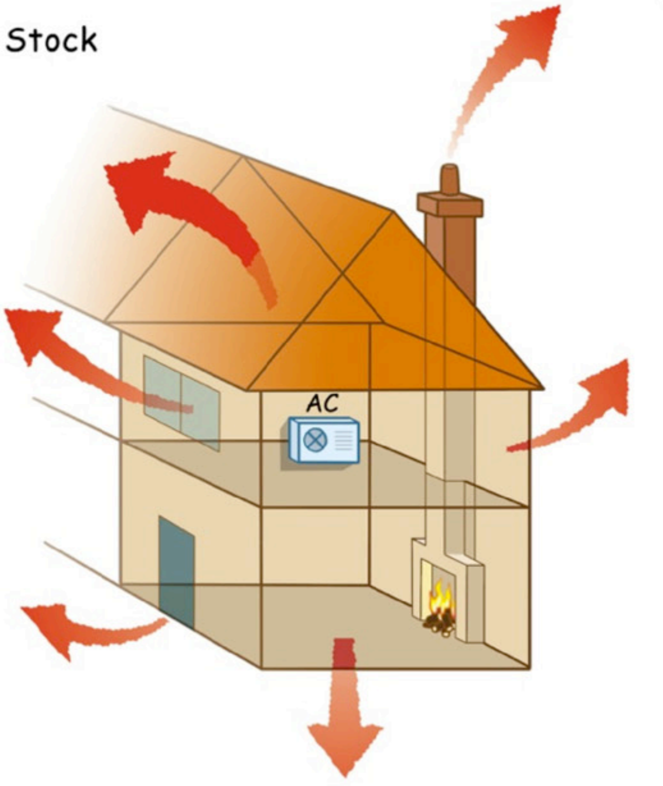
ENERGY CONSERVATION

Side Elevation



Current Stock



Floor Construction

The slab from the top down is a compound construction of a main slab, insulation, membrane, blinding slab, and with a 0.45m lowered foot along the back (north) edge.

The lower blinding slab in the foot has no steel reinforcement mat and was poured first and power floated smooth. A wall of lightweight blocks was built on end without mortar along the inner edge. The top of these formed the top edge of the upper blinding slab. The upper slab was poured in two longitudinal strakes for ease of access of the delivery lorry, which had a short chute. The slightly proud edges were dressed smooth and the exposed edge of the wall was radiused to take the damp proof membrane (dpm).

The longitudinal foot is a ground anchor, which takes the horizontal force from the ground at the back wall into the ground beneath the houses and relieves the compound slab of shear stress, or slip, in the plane of the membrane or insulation.

Completed sub-slab – Note soil on left to be used later to cover roof

Replication issues

A slab of this size is more akin to civil engineering than house building and must be properly set out and laid. The whole available workforce needs to be organised to handle such large single pours. Other builders may opt for individual house slabs with movement joints.

Concrete for bases or footings should have sufficient qualities to protect against chemicals in the ground. Construction with unprotected concrete has to be timed for dry, frost free weather.

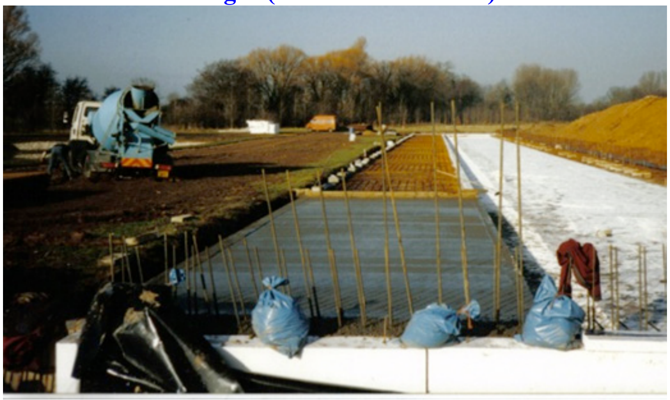
Insulation and membranes

A layer of 300mm "Jablite" expanded polystyrene insulation blocks were laid along the lower blinding slab and a single roll of Monarflex Blackline 500 polyethylene waterproof geomembrane (the dpm) was laid on the lower blinding slab. The membrane is 0.5mm thick and extremely tough and extensible. Joints were made by heat welding by the supplier's staff. The Jablite insulation has a k-value of 0.034W/mK, a compressive strength of 110kPa and a safe working load of 45kPa (at 1% compression) – the actual load has been calculated at 32kPa, well within safe limits (see appendix 3). The 300mm insulation blocks were butted together and laid over the 6m width of the house with a 150mm vertical section to make a former, which became a thermal break between the slabs of the conservatory and main part of homes.

Water proof membrane on blinding slab with insulation placed on top

Steel reinforcement mats were laid for the main house slab above the insulation with a line of preformed 90^0 corner bars along the edge and the ends turned upwards to make the slab integral with the rear and end walls. A continuous pour of concrete was made by running the lorries along the front of the blinding slab.

Main slab partially complete. Note steel mats in distance and insulation on right (main house section)



Replication issues

It is important to ensure a perfectly smooth surface to lay the membrane on.

Insulation blocks must be tightly butted to avoid cold bridges from air gaps or trapped water. However it maybe impractical in wet weather to avoid some trapped water as with HHP – the effect is indeterminate and unlikely to cause anything more than an imperceptible settlement.

The continuously welded membrane which extends around the whole of the underground part of the structure is expected to be impervious to radon gas if any is present in this area. There are no holes through the slab (nor any other part of the underground structure) for soil pipes or services so that the insulation and membranes are not perforated.

Front former

A single block underground wall was built with two top rows of blue bricks as a former along the front line of the conservatories. It was then lined with insulation blocks. Reinforcement mats were laid and the concrete poured.

Replication issues

Care must be taken to provide sufficient support to the outside of single brickwork to withstand the hydrostatic pressure of wet concrete from the inside.

Corner detail

One particular problem was the detailing of the two end corners where the slabs meet the back and end walls. A concealed latent defect needs to be avoided. The structural concrete, membrane and insulation all have to be continuous in the three directions and the detail had to be carefully considered to enable this corner to be built.

Rear wall

Along the back edge of the main slab a double skin wall of 100mm concrete blocks with a 300mm gap was raised by about a metre and a vertical reinforcement mat located in the centre of the gap and overlapping the vertical part of the bars projecting from the slab. Concrete was poured into the gap to form a reinforced wall of 500mm thickness integral with the slab. Two further ‘lifts’ took the wall to its full height of 2.2m (internal). The two end walls, which project to the front of the conservatory, were built in the same way. Performed 100^0 corner bars were set into the top of the concrete to allow the wall to become integral with the reinforced screed of the roof.

Rear wall partially complete

Replication issues

A 500mm concrete wall is an unusual feature for a house but it was more simple to build in this way than by using shuttering. This also avoided the waste of timber associated with shuttering.

Internal walls

The internal walls were made from a double skin of 100mm dense concrete blocks built across the house slab at 3.2m centres. Walls within each house included doorways with concrete lintels on 200mm bearings and the end walls of each house were plain. The top line of blocks was cut to a slope to take the roof from 2.2m up to 3.3m at the front. Wall ties were used between the internal walls and the back wall rather than the walls being block-keyed as normal. In our case the strength is in the reinforced concrete wall. The only significant load on the cross walls are from the roof.

Internal walls making 31 bays

A block was left out at the back floor corner of each internal wall for the soilpipe and services. Two half blocks were left out above doorways for ventilation pipes (see image below).

Lintels and provision for ventilation pipes

Roof (beam and block)

The roof was constructed by machine-lifting 3.2m precast beams onto the walls to span the bays and manipulating and infilling by hand with dense concrete blocks.

Forklift truck lifting beams into place

Beam and block roof partially constructed

A 100mm reinforced concrete screed was laid over this roof. The whole structure is therefore a very strong rigid box form to take the soil overburden and the side force on the back wall. The structure has no flexible joints in the slabs or walls as temperature variability in the structure are minimal.

Replication issues

This roof element is similar to concrete floor construction and is a familiar process. A longer beam would have been much heavier but still would not have been unduly difficult to place, particularly with the use of a crane.

Remaining membrane and insulation detail

A 50mm layer of polystyrene was first placed against the back wall followed by the dpm and a further 250mm of insulation. A layer of compound draining membrane (Geofin) was placed over the insulation with its lower edge in the gravel bed containing a land drain.

Back wall insulation – Note dpm under insulation

The two end walls of the terrace were covered in a similar way. The Geofin membrane comprises an outer water-pervious textile layer attached to 8mm high flat topped cones projecting from the inner water proof layer, to give a drainage space. These membranes only need to be overlapped to be effective: no jointing is required. Any piercing of the draining membrane would have a negligible effect on the waterproof integrity of the system. Its function is to relieve the hydrostatic pressure.

Back wall infill – Note the Geofin layer (paler coloured sheet between earth and dpm

Roof & earth covering

On the roof a 50mm layer of polystyrene was laid over the poured concrete. Then the dpm was put down with 250mm of insulation on top of this. The insulation was subsequently covered by a second sacrificial membrane and a root barrier before finally loading on the sub and top soil.

Dpm being laid on thin insulation off cuts – Main insulation blocks on side waiting to go on dpm

The structure was covered with soil from the excavated subsoil and topsoil. The surface was grassed and sloped smoothly to join the field at the rear. The soil avoids alternative roofing materials and returns much of the original green footprint to the development site. The soil has a high thermal capacity and protects the insulation surface from radiation losses during cold periods.

Replication issues (Roof)

The construction of the roof was simple. Access is easy for cutting overgrowth 2-3 times a year, although more recently sheep have been used to the same affect. The concern over the soil drying and causing the grass to die has proved unfounded.

Earth tubes

At each end 2m diameter concrete rings were placed on their side to form future cellars, covered with membrane and soil but no insulation.

Earth tube located on end wall

Earth tube covered and grassed (some time later)

Front wall

The front wall to the house is of concrete blocks and clay facing bricks. It has a 150mm insulation filled cavity with plastic ties and extends upwards above the roof apex to form a retaining wall for the soil on the roof. The wall is capped with a double row of paving slabs bedded onto a copper flashing sheet which overlaps the top edges of the two membranes. Each bay has a 1.8m wide full height (3.3m) glazed frame. At the top of the inner skin at each opening is a concrete lintel which supports four rows of Thermalite blocks and the capping slabs. The weight of nine rows of clay brickwork above the openings is taken by a shallow brick arch which is infilled with matchboard ply down to the head of the frame. The facing brickwork was done by locally imported labour and the bricks made in Yorkshire using landfill methane for firing.

Front wall construction

Front wall and porch construction – note plastic wall ties from inner leaf of blocks

The wall cavity insulation is contiguous with the 150mm insulation break between the slabs such that the inner leaf of block stands on the house slab and the facing brickwork stands on the conservatory slab.

The wall cavity is not closed at the openings with a return of brickwork, as was standard practice, to make the two leafs act as a single structural member. The closure is by a 25mm ply frame into which the glazed frames are fixed. The detail eliminates the large cold bridge of masonry which normally occurs at all window and door openings and in this case there is no technical problem as the walls are single storey and neither of the leafs of the wall is a structural member.

Replication issues

The use of wall openings without brickwork returns needs special attention to detail. Wet plaster applied later improves air tightness between liner and blockwork.

Glazing

The frames in the house front wall all have a large glass area with a a double door and an opening light above. The frames are sustainable softwood of high quality manufacture with triple-glazed argon filled sealed units and an internal low-e coating. The windows and doors close onto soft integral seals.

Newly fitted doors and windows to main part of home

The conservatories have a low outside wall, timber frames with double-glazed units and two double external glazed doors. The wall is insulated with 150mm “Dritherm”. In each bay is located a Velux opening light in the roof situated very close to the opening window in the wall frame to give good clear natural ventilation to each room.

The porch and conservatory timber glazing bars and sills are the only parts of the house to be exposed to the weather reducing considerably maintenance to fabric of building as a result of weathering.

Conservatory timber frame

Conservatory glass being fitted

Replication issues

The conservatories are a major amenity feature with a large floorspace and as an integral part of the construction were built for a relative low cost.

Replication (House construction general)

The construction was managed by a professional builder whose expertise was an evident factor in the standards achieved in the building work and infrastructure. There were no undue difficulties in building the superstructure. There were normal site management needs of organising supplies on time to avoid unwanted build-up materials, or shortages. This applied in particular to ready-mixed concrete and mortar.

While especially valuable to earth covered construction, the elimination of apertures through the structure is a good feature, which could be more widely adopted.

The construction of the house with reinforced concrete, dense concrete blocks, 300mm polystyrene, etc compared with standard breezeblock, facing bricks and much narrower insulated cavities may seem like an expensive approach. However this needs to be off-set against savings in heating systems and long term energy costs.

If houses with 300mm of polystyrene were built above ground the problem of fixing and the cost of external cladding would arise and may require an expensive solution. The soil cover of the HHP houses neatly avoids this issue.

Sources of materials used

COMPANY	MATERIALS SUPPLIED
Architectural Design	Professor Brenda and Dr Robert Vale
Construction (Merchants)	
Keyline Builders Merchants (Nottingham),	Many and various building materials
Construction (Materials)	
Tarmac	High density concrete blocks (topblock)
Newark Concrete	Concrete for slabs and infill
Vencil Resil	Polystyrene insulation blocks
Crown	Dritherm insulation for front wall
Marshalls	Floor beams and facing bricks
Manson Timber (Now Timber Centre, Newark)	Wood
Monaflex Geomembranes Ltd.	Tanking membrane / dpm
Stanton Bonna	Concrete rings for water storage/ earth tube
Glazing Products	
Pilkington	Double-glazing to Conservatories
Velux Roof Windows	Skylights for porch lighting, and conservatory ventilation
Swedhouse	Triple glazed doors and windows

Appendices

Appendix 1 – Criteria for choice of materials

The following table provides an overview of selected products and reasons for their inclusion.

PRODUCT	PROPERTIES
Concrete Products	⇒ High thermal mass ⇒ Structural strength ⇒ Locally sourced
Insulation Products	⇒ High compressive strength ⇒ CFC, HCFC- free and no off- gassing ⇒ Resistant to fungal attack ⇒ Non PVC
Facing bricks	⇒ Fired from waste methane gas
Glazing Products	⇒ Very high thermal performance, timber frames from sustained forests. ⇒ Conservatory: High thermal performance
Drainage Products	⇒ Clayware (non petro-chemical based where possible) ⇒ High compressive strength (minimal quarry products required for bedding)
Pump Products	⇒ Correct power and flow rates ⇒ Rated for continuous operation ⇒ Sewage pump all plastic
Timber Products	⇒ Sourced from sustainable forests. ⇒ Careful selection of wood based products

Sanitary Ware	⇒ Aerating ⇒ Low flush ⇒ Water saving
Decorative Products	⇒ Low VOC/low energy paints, lead free paints, stains and washes
Plumbing Products	⇒ Copper & Tin ⇒ Polypropylene (non PVC*, lead or zinc) ⇒ Lead free solder ⇒ Aerating taps and shower heads ⇒ Discarded fruit juice containers for HWS solar storage
Electrical Products	⇒ Non-PVC cables in houses ⇒ Mechanical Ventilation and Heat Recovery systems and heat pump for hot water ⇒ Low energy lighting and appliances
Water Systems	⇒ Grey water reservoir to hold 150 cubic ms ⇒ Potable water storage to hold 25 cubic ms
Hard Landscaping	⇒ Access road to be unobtrusive but to meet building regulations ⇒ Hardcore reclaimed for road ⇒ Topsoil retained and used on roof and house surrounds

- Why not PVC? - When PVC burns it gives off hydrochloric acid, dioxins and phosgene, and is suspected of outgassing. Cables used, Low Smoke Zero Halogen (LSZH), do not emit any poisonous or corrosive acid gases when exposed to fire.

Appendix 2: Concrete and block dimensions for a 6-bay house (general)

	Horizontal Area (m^2)	Thickness(m)	Volume(m^3)	Density (kg/m^3)	Mass (tonne)
CONCRETE					
Roof (mix of concrete & block)	127	0.25	31.75		
Slab	127	0.30	38.1		
Wall (rear)	43.2	0.30	13.0		
Sub-total			82.9	2100	174
BLOCKS					
Wall (rear)	43.2	0.20	8.6		
Wall (front)	32	0.1	3.2		
Wall (inter)	99	0.20	19.8		
Sub-total			31.6	1900	60
TOTAL					**237**

Appendix 3: Bearing pressure in insulation

Total weight of concrete in a house above the base insulation is calculated in Appendix 1 =**237 tonne**

Weight of soil on roof = Roof area X depth of soil X density saturation
= $121m^2$ X 0.4m X $1200kg/m^2$ = **58 tonne**

Therefore Total Weight = 237 + 58 = **295tonne**

Bearing pressure in insulation = 295,000kg X 9.81N/kg / 6.65m X 19.2m = = **$23N/m^2$ (or 23kPa)**

(Manufacturer's safe working load = 45kPa)

General Advice

The environmental impact of a home is not just the effect on its immediate surroundings. The design of the home and choice of materials will affect both its local and the global environment. However there are ways to reduce its impact. In developing your designs and plans you may wish to consider the following questions: -

What general issues should be considered?

- ❖ Minimise energy required for construction by considering how much energy is required to:
  - ➢ Manufacture, transport and install the product/material (embodied energy)
  - ➢ Thermal performance of materials and the effect on energy consumption (energy efficiency)
  - ➢ Lifespan of materials/products (durability)
  - ➢ Disposal of product at end of its useful life (reusability, recyclability).
- ❖ Minimising negative impact on local environment:
  - ➢ Are toxic chemicals released during life of product?
  - ➢ Are chemicals needed to be applied to the product (e.g. timber treatment)?
  - ➢ What impact of product on indoor air quality (e.g. off- gassing)?
- ❖ Minimising negative impact on global environment:
  - ➢ Choose materials/products that result in minimal impact on land or resources
  - ➢ Toxicity during manufacture and transportation
  - ➢ Release of greenhouse gases (mainly CO_2), acid gases and CFC's during manufacture & transportation
- ❖ Minimise use of materials/products with high non-recyclable content and/or with poor recyclability at end of their useful life.
- ❖ Environmental policies of manufacturers and suppliers.

What are the alternative, environmental building designs?

- Passive solar - Use the sun to warm interior of building directly through windows or a "sunspace" (e.g. conservatory). The building structure is designed to store the heat and release it when air temperature drops.
- High thermal mass - Use materials with a high capacity to absorb heat energy that can be later released as air temperature drops.
- Timber frame - A form of lightweight construction using timber to provide a structural framing system usually then clad with brickwork to provide the rainscreen.
- Earth-sheltered - Use earth covering to provide additional insulation and/or reduce visual impact.
- Low impact - One that conforms to many of the following criteria: is temporary, small-scale, unobtrusive, made from mainly local materials, enhances local biodiversity, uses a low level of non-renewable resources, generates little traffic, used for a sustainable purpose, linked to a recognizable positive environmental benefit.
- Autonomous - Uses local resources to supply energy and water needs.

How can the energy used to manufacture and deliver materials ('embodied' energy) be reduced?

- Reuse materials already on site, e.g. soil.
- Use reclaimed materials, or if not, recycled materials (such as aggregates) for construction.
- Use minimally processed materials (i.e. not highly manufactured products such as plastics)
- Source locally produced materials reducing transport impacts and sustaining local employment.

How can the longevity of a building be increased?

- Incorporate durable materials and products (balanced against their effects on the environment).
- Design detailing that protects the building (such as deep roof overhangs).
- Incorporate tough, weatherproof materials for exposed areas of the building exterior.

What sort of timber should be used?

In order of preference use:

- Above all, avoid threatened species, particularly tropical hardwoods
- Second-hand timber
- Timber composites and panel products that contain a high proportion of recycled material.
- Home-grown certified timber.
- Imported timber accredited with Forestry Stewardship Certification (FSC).
- Also consider where possible using wood that does not require treatment.

What other specific materials should be considered?

- Recycling brick, stone, glass and concrete for aggregates reduces environmental damage from extraction and waste disposal.
- Despite the large amounts of energy needed to refine metals, they are durable and relatively easy to recycle, such as steel.
- Specify high quality timber window frames rather than uPVC or aluminum.

What products should be avoided?

- Lead based products.
- PVC – use alternatives such as polyethylene and polypropylene for pipework (can be both recycled and incinerated) and clay for large bore pipes.
- Materials using CFC or HCFC - use Zero Ozone Depletion Potential (ZODP) materials (e.g. polystyrene based insulations)

What should be considered to prepare for impacts climate change?

- Increasing resistance of building envelopes to penetration by driving rain.
- Incorporating passive ventilation and greater thermal mass
- Incorporating features which reduce excessive solar gain
- Design to reduce aerodynamic loads
- More attention to ground stability and foundations where there is greater risk of subsidence

Further Resources

Websites

- **Association for Environment Conscious Building** (www.aecb.net)- leading independent environmental building trade organisation in the UK that encourages greater environmental awareness within the UK construction industry. Also publish quarterly magazine *'Building for a Future.'*
- **Building Research Establishment (BRE)** (www.bre.co.uk) - includes 'Centre for Sustainable Construction' providing expertise that can be used to help you reduce environmental impact and associated costs spanning the whole life cycle of a building. Also provides practical guidance in relation to materials specification, construction and management.
- **CIRIA** (www.ciria.org.uk) - Research association concerned with improving the performance of all involved with construction and the environment. CIRIA encourages the application and improvement of best practice through its networks, including the Construction Industry Environmental Forum (CIEF) which aims to improve the environmental and sustainability performance of all those interested in construction.
- **Construction Best Practice Programme** (www.cbpp.org.uk)
- **Construction Resources** (www.ecoconstruct.com) - An ecological building merchant
- **DTI Sustainable Construction** (www.dti.gov.uk/construction/sustain/)
- **Forestry Stewardship Council** (www.fsc-uk.demon.co.uk) for news and information, on
- **Natural Building Technologies** (www.natural-building.co.uk) - An ecological building merchant
- **Newbuilder GreenPro** (www.newbuilder.co.uk) - a subscription online service providing a library of eco-building products.
- **Sustainable Homes** (www.sustainablehomes.co.uk) – includes an eco-database of environmental housing schemes.
- **Sustainability Works** (www.sustainabilityworks.org.uk) - includes section on building.
- **The Green Building Store** (www.greenbuildingstore.co.uk) - An ecological building merchant
- **Timber Recycling Information Centre** (www.recycle-it.org)
- **ZED Factory** (www.zedfactory.com) - a range of tools to support sustainable development schemes, including: design, product specification, best value for appropriate products, and use of tried and tested innovative environmental technologies.

Further Reading

- **Beddington Zero (fossil) Energy Development – Construction Materials Report (Toolkit for Carbon Neutral Development)** - includes assessment of cost-effectiveness and environmental benefit of key materials. (Copies from BioRegional Development Group, www.bioregional.com, 020 84044880)
- The **BRE Environmental Assessment Methodology (BREEAM)** – assessment method to determine environmental impacts of many non-domestic building types both new and refurbished. (see www.bre.co.uk).
- **EcoHomes** - homes version of BREEAM. (See http://www.bre.co.uk/sustainable/ecohomes.html)
- BRE's software tool **envest** is a complementary tool to BREEAM, which allows users to assess the life-cycle environmental impact of a proposed building and to explore various design options. (see http://www.bre.co.uk/sustainable/envest.html)
- **Building a Sustainable Future – homes for an autonomous community (GIR53)** – (Copies available from BRESCU enquiry line 01923 664258 or see www.housingenergy.org.uk).
- The **Good Wood Guide** by Friends of the Earth for general information and sustainable timber products (see www.foe.org.uk)
- **Green Building Handbooks, Volumes 1 &2** (T Wooley, S Kimmings, et al) - Compare the environmental effects of commonly available products with less well known green alternatives.
- **Handbook of Sustainable Building: An Environmental Preference Method for the Selection of Materials for Use in Construction and refurbishment** (Anik, D et al 1996) – An easy to read guide that offers sustainable alternatives to standard material/product specifications.
- **Searching for Sustainable Timber**. For a free copy call SCA Timber on: 01724 784784
- **Sustainable Housing Schemes in the UK (HHP)** (See www.hockerton.demon.co.uk)
- **The Green Guide to Housing Specification** (see www.bre.co.uk)
- **The New Autonomous House-Design and Planning for Sustainability (Brenda & Robert Vale)** (Thames & Hudson)
- **The Real Green Building Book** (see www.aecb.net) – list of environmental building professionals.
- **The Whole House Book: Ecological building design and materials** (Pat Borer & Cindy Harris) (see www.cat.org.uk)

Other Case Studies

- **David Wilson Millennium Eco-Energy house (University of Nottingham)** – Passive solar, high tech south-facing orientation, high specification windows, light pipes, etc (www.nottingham.ac.uk/sbe/)
- **Millennium Green (Collingham)** – 25 properties using ppassive solar design, high thermal mass, high proportion of building materials sourced locally. (see www.gustohomes.com)
- **Nottingham Eco House**- Renovated house has been used to test new products from the eco building market. Passive solar, high thermal mass, extensive use of recycled materials (see www.msarch.co.uk/ecohouse)
- **The Autonomous House, Southwell** – UK's first Autonomous House. Passive solar, high thermal mass, low impact, autonomous, high proportion of building materials sourced locally, extensive use of recycled materials (e.g., house foundations rest on demolition rubble from old brick buildings), selection of materials based on careful assessment of their embodied energy (e.g. bricks fired using waste methane gas).
- **BedZED Project**, Sutton (www.bedzed.org.uk)

References

Hockerton Housing Project Construction Report, Sept 1998 (Databuild Ltd)

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