



## Q37 Green Roof Specification

### Environmental Issues: Roofing

- Ice caps melting
- Atmospheric pollution & global dimming
- Earth's albedo reducing:
  - roof coverings can compensate
- Global warming
- Climate change
- Water demand
  - SE England water stress
- Urban heat island effect

### Biodiversity

- Farming techniques drives wildlife to the cities
- Cities offer little habitat & food source,
- Living Roofs offer a solution
- Be sure to plant and landscape according to local inhabitants and nature's needs
- Nesting and bedding to suit
- Plant species by Postcode is offered
- Nectar bars to support pollinators and indigenous fauna



## Environmental Issues

### Earth's Albedo: 0.39 (reflectivity)

- There is a hint of survey evidence that it has decreased 2.5% over the past 5 years!
- <http://abob.libs.uga.edu/bobk/cc042001.html>
- If it keeps on decreasing at that rate for 40 years, will the albedo of Earth be zero?
- All the clouds would have to disappear and the oceans and land turn black.
- Runaway greenhouse such as Venus indicates total cloud cover and high albedo.
- Nuclear winter would involve total cloud cover.
- Global warming itself indicates increased clouds as the oceans boil away.



## Development Control

### Environmental Issues: Green Roof

- Ice caps melting
- Atmospheric pollution & global dimming
- Earth's albedo reducing:
  - roof coverings can compensate
- Global warming
- Climate change
- Weather and Precipitation Water
  - Water demand
  - SE England water stress
  - Rainwater harvesting
- Urban heat island effect
  - Living roofs are Cool!
- Biodiversity:
  - indigenous nature being forced further north and squeezed out of many places
  - Green roofs: potential habitat

### 'Urban heat island' effect

- Solar gains on façades of buildings
- Radiant heat to other buildings and passers by
- Relatively static air between buildings in cities
- Heat losses from interior to exterior of buildings
- Irregular street patterns (London) hinder ventilation cooling

### Planning & Legal context

- Rio: Local Agenda 21
- Habitat Directive
  - Habitat Regulations
- PPG17
- PPG9 > PPS9
- Defra publications
- BAP Biodiversity Action Plans
- EIA Environmental Impact Assessments
- BREEM & EcoHomes





# Roof Design Issues

## Roof Design Issues

- Weather: Rainfall
- Weather envelop
- Structural Deck
- Thermal insulation
  - r, k & U values
  - G values decrement and thermal mass
- Acoustic mass
- Lightning protection



## Weather:

- An inevitable part of looking at an external envelope of a building
- The planet is changing, rapidly
- Climate changes will force us to respond and designs will evolve, I hope
- Rethink the performance of buildings

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## Weather:

- As weather conditions become more extreme, we need to make our external envelopes:
- More: thermally insulating, flexible, watertight, forgiving and stronger
- airtight, vapour permeable, thermally massive, moisture massive, carbon neutral or carbon negative, etc.

## Rainfall

- Prolonged periods of heavy rain are likely to lead to greater incidences of flooding and leakage through the external envelop.
- At the moment there are three conventional means by which we keep building envelops watertight

## Weather Envelope



Absorbent – Repellent – Open Joint Panelled Masonry – Curtain Wall – Rainscreen Living Roof – Roofing membrane – Slabs on props

## Weather Envelope



Absorbent – Repellent – Open Joint Panelled Masonry – Curtain Wall – Rainscreen Living Roof – Roofing membrane – Slabs on props

## Structural Deck

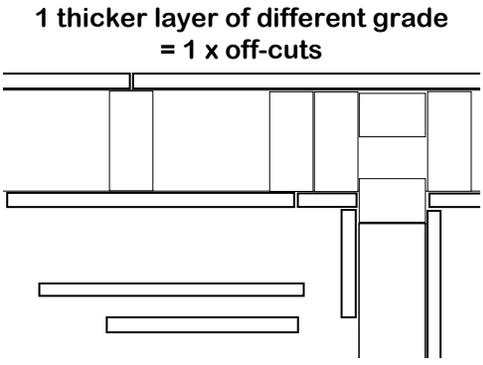
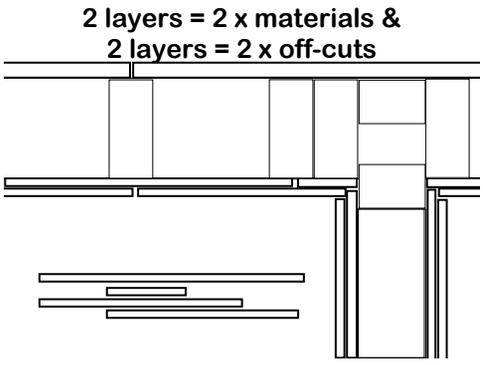
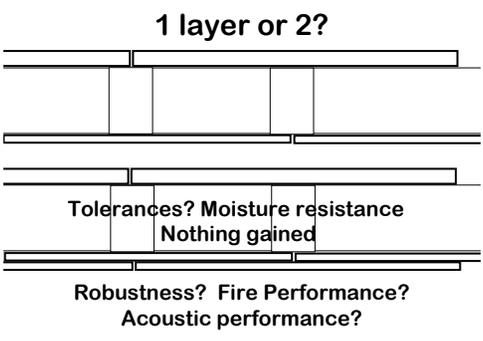
- Timber Deck
  - Joists or compound joist and board
  - SIPS Structural Insulated Panels
  - Solid timber structural panels
- Concrete Deck
  - Insitu
  - Precast plank
  - Beam and block
  - Insitu and clay pots
- Composite Deck
  - Steel trough deck and insitu concrete

## Timber Flat Roof: Eco

- Suited to solid wall or framed buildings
- Frames from column and posts
- Timber I beams minimise resource use
- Suspended above accommodation
- Well insulated for Zero Carbon Future, airtight and no cold bridges
- Breathing Construction and insulation
- Thermal mass can be added

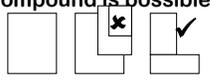


**Reused wood better than new**  
 BedZED Buildington Sutton Architect: Dr Bill Dunstan  
 Reclaim: Regional ReCLAIMED © NGS

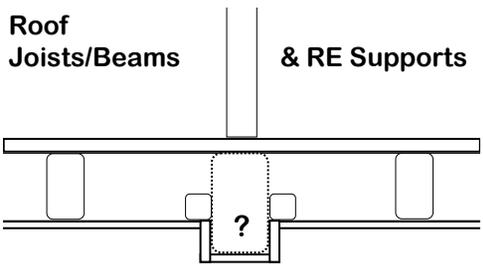
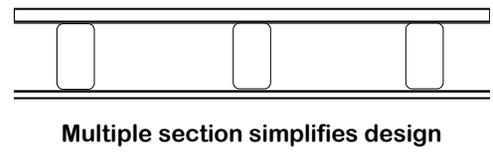


**Reduce Demand**

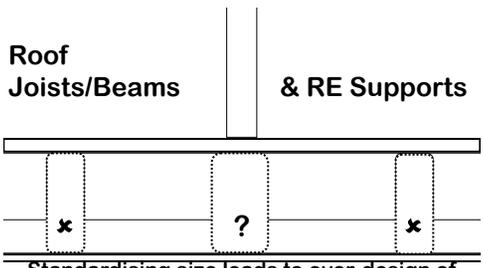
- Don't over design structure
- Except if long design life demands it
- Don't oversize
- Don't cut section from solid if compound is possible



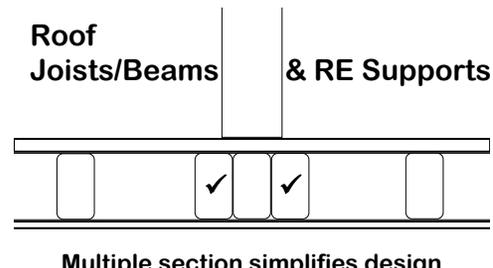
**Roof Joists**



Different section complicates detail  
Creates off-cuts and waste  
Changes appearance below



Standardising size leads to over-design of many for the sake of one  
No harm done by extra insulation  
Future proofing: RE support, later RE add-on

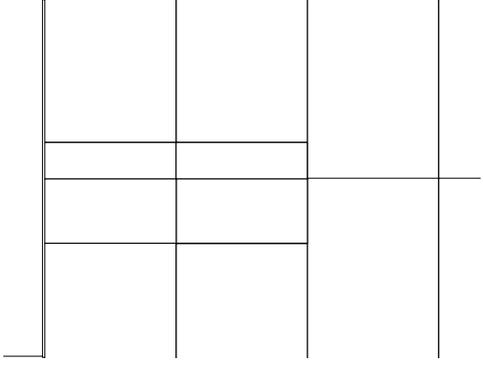
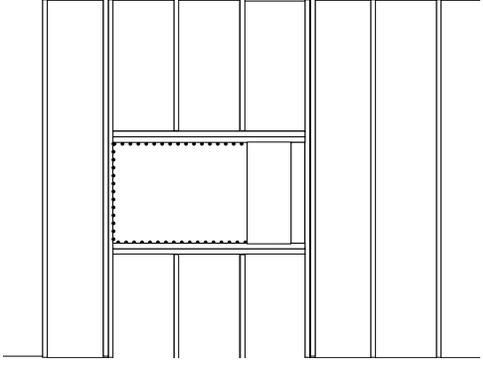
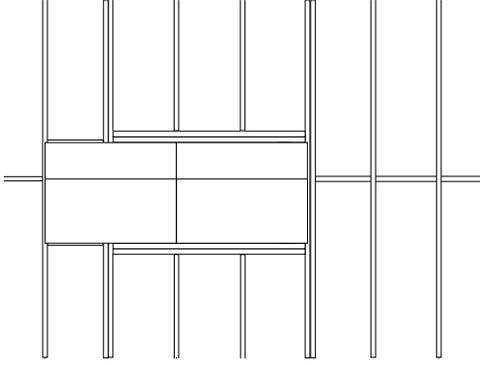
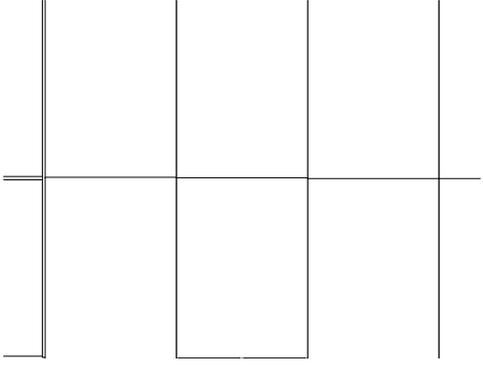


Multiple section simplifies design

**Trimming of openings  
flat or pitched roof section**

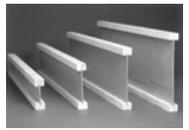
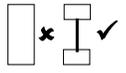


Lazy Structural Design: less calculation, more structure  
 Avoid over design of structural supports or around openings  
 Avoid creating wide cold bridges through insulation  
 chopping standard width insulation rolls: more waste



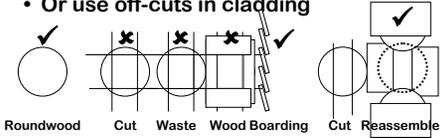
**Reduce Demand**

- Don't cut section from solid if compound is possible
- Reduce solid sections to compound to reduce weight and materials used

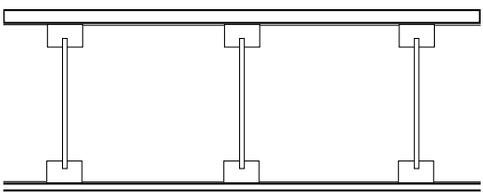


**Reduce Demand**

- Consider use of materials as found:
- Round pole structures
- Or compound sections without waste
- Or use off-cuts in cladding

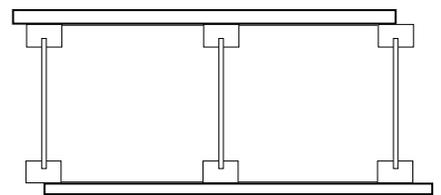


**Compound roof joist 'I beams' to accommodate more thermal insulation**



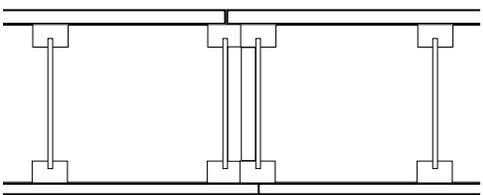
Compound section reduces amount of materials used and weight

**Compound roof joist 'I beams', inner and outer boards and thermal insulation**



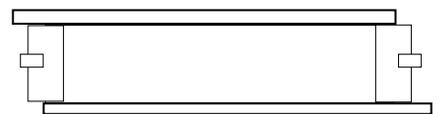
Prefabricated external roof or wall panel

Compound roof joist 'I beams', inner and outer boards and thermal insulation



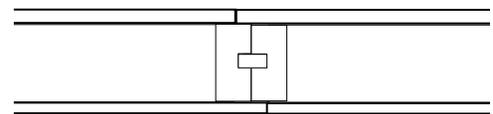
Prefabricated external roof or wall panel

SIP Structural Insulated Panel



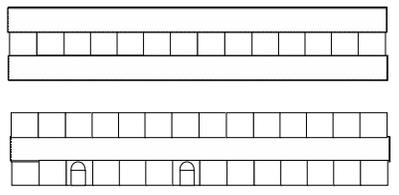
Prefabricated external roof or wall panel

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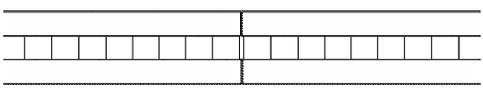
Prefabricated external roof or wall panel

Load-bearing Structural Timber Panel



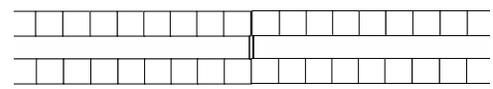
Prefabricated external flat or pitched roof or wall panel, floors and partitions

Load-bearing Structural Timber Panel



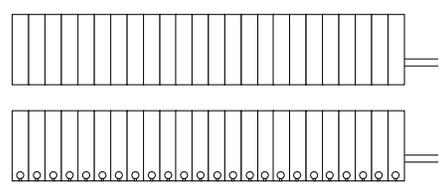
Prefabricated external flat or pitched roof or wall panel, floors and partitions

Load-bearing Structural Timber Panel



Prefabricated external flat or pitched roof or wall panel, floors and partitions

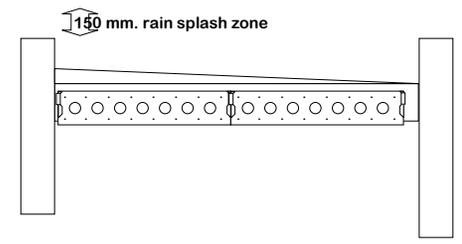
Load-bearing Laminated Structural Timber Panel

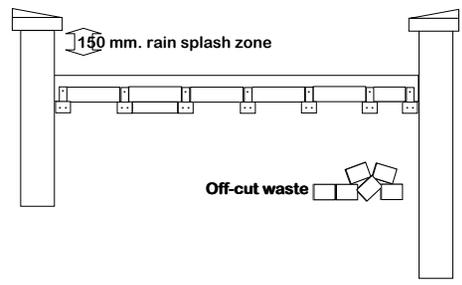


Prefabricated flat roof and floors with acoustic absorber slot option

**Suspended Roof:  
Economic & common:**

- Suspended insitu concrete is labour intensive and not common
- Precast concrete plank and structural screed topping Cement:Sand
- Precast concrete beam and concrete block with topping
- Hybrid mixtures of the above
- Holes drilled (cored), cut or trimmed





Metal Trough & Insitu EcoConcrete



- Requires steel frame superstructure
- Steel Permanent formwork deck provides access
- Insitu eco-concrete
- Bond and together to make thin floors
- Potential reduction in storey heights



Roof Design Biodiversity Issues



Dwellings



- Roof voids
- Sunny side of roof
- Walls
- Wall mounted boxes
- Sunny side of house

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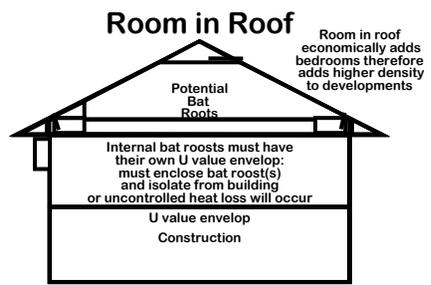
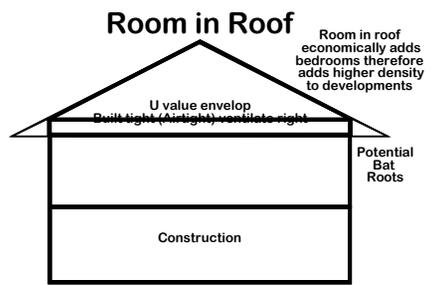
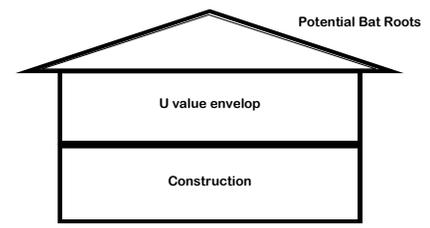
Definitions



- U value envelop
- The line that envelops the human accommodation in a building
- Which includes thermal insulation, airtightness layer (or vapour barrier and breather membrane) ideally close together no gaps
- And excludes cold bridges through the insulation

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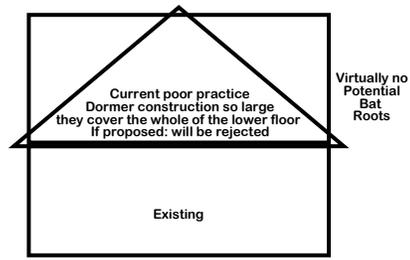
Attic in Roof



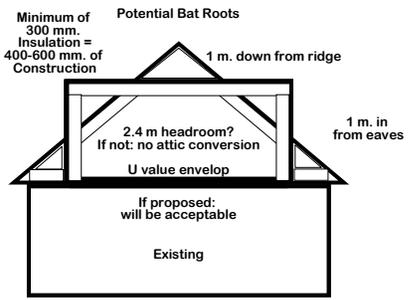
T&CP Permitted Development Consultation 2007

- Simplification of the planning process
- Generates 27 rules to replace the 6 that exist – (government joined up thinking at its best)
- Attic conversions:
  - Basic principles that make some sense
  - Complicated by improvement in U values and need for natural lighting and natural ventilation
- But reintroduce bat roost potential

**Attic Conversions: Bad**



**Attic Conversions: Good**



Rejected:



- Planning Consultation overwhelming message the proposals rejected

**Thermal Insulation U Values**

- Global warming
- Need for better Insulation standards
- Building Regulations Approved Document L is not good enough
- SAP method is not good enough, needs updating and will be
- Code for Sustainable Homes (other buildings later) will start the drive
- albeit a Voluntary Code until spring 2008
- with optional levels of achievement

**U-values are crucial in this process.**

- U-value is the measure of how resistant the external envelope is in total to the passage of heat
- we need to aim for a low U-value to prevent a building from gaining or losing heat too rapidly



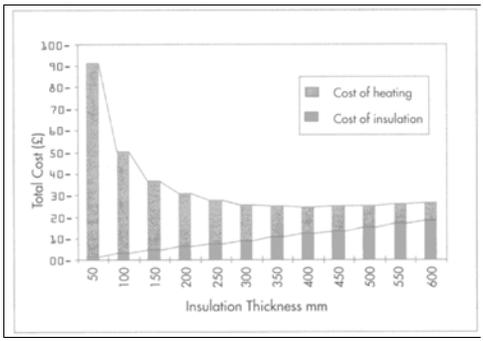
U Value Calc.



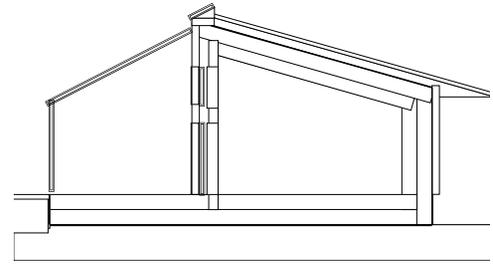
- The U-value is calculated by adding up the k-values of each of the materials that together make up the external envelope.
- The k-value is in turn calculated by multiply the resistivity (r) of a material by it's thickness.

**Preoccupation with thinness**

- Speculative developers are preoccupied by net to gross ratios
  - MIPIM 2007 might have changed that,
  - 36,000 developers sipping champers for 72 hours
  - talking sustainability!
- Walls thickness and floors heights get scrutinised
- Do roofs slip the net?
- Thinness forces the choice of high performance insulation with high GWP GHGP



**Insulation wrapped around accommodation and thermal mass**



### G-Values

- The G-value is a characteristic that is new to us
- which the Germans have been promoting for some time
- characteristic recorded in technical literature
- It is a measure of decrement and concerns the way heat is held within the insulation not just passes through it

### G-Values

- Slow uptake of G-values in Britain
- many insulation material on the market that can exploit this characteristic
- Dense cellulose fibre insulating boards
- Insulated render system carriers & mineral based thin render systems
- replacing expanded polystyrene and synthetic/acrylic renders.

### Thermal Mass & Thermal Insulation

- there is an opportunity to exploit a combination of U value and G value in one material
- Include thermally massive, thermal insulating materials in the exterior envelope of a building
- not only slow the movement of heat down, but store that heat as well

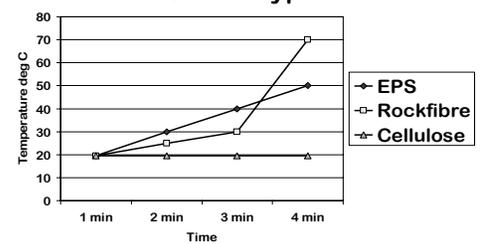


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### Expanded foamed glass thermal insulation

- Can be a challenge with liquid applied asphalt roof waterproofing
- Insulation absorbs heat from asphalt and bounces it back to the asphalt preventing it from cooling
- On slopes this flows until cool enough to set so needs pushing up hill until then

### Radiant heat through 50 mm. of thermal insulation types over time



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### Pavetex's Diffutherm Natural Building Technologies

### Cellulose Fibre

- High acoustic density & high thermal mass
- Cellulose fibre insulation boards in:
  - Walls
  - roofs
- Impressive performance compared to:
  - glass/rock mineral fibre
  - expanded polystyrene plastics insulation

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### Thermal Mass: Winter

- Thermal mass (TM) of dense materials, offer capacity to capture and store heat for beneficial use later
- In the heating season, high TM materials exposed to sunlight, store heat and release it after the sun is gone keeping the room warm into the evening, insulation beyond the TM will prevent the heat from being lost

**Thermal Mass: Summer**

- In the summer heat hitting exterior of a building could warm the people inside,
- High TM heavy masonry building protect the occupants
- Common practice in Mediterranean climates
- Exploiting TM can protect us from the rapid fluctuations in external temperatures.

**Exploit Thermal Mass Don't Ignore It**

- TM is only beneficial if you exploit it.
- In conventional cavity wall construction:
- brick outer leaf that will capture heat,
- insulation that will stop it moving through the wall
- insulating concrete blockwork
- insulating plaster on the inside
- Heat captured in the brick is wasted
- potential TM in concrete block not realised

**Exploit Thermal Mass Don't Ignore It**

- However, architects like Bill Dunster, who do understand TM
- are designing buildings that make the most of this characteristic
- exposing concrete floor and roof soffits in buildings like BedZED

**Zero Energy Development**



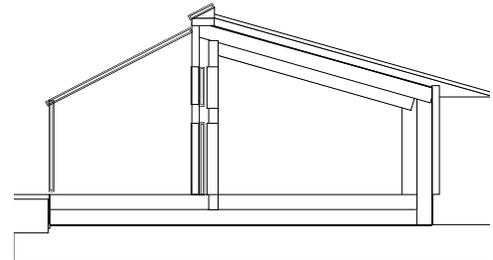
Reduce demand for artificial light and heating: Outdoor living Conservatory life sunny warm cave to retreat to in the cold of night

Hockerton Newark Nottinghamshire



Hot house in the middle of winter

Insulation wrapped around accommodation and thermal mass

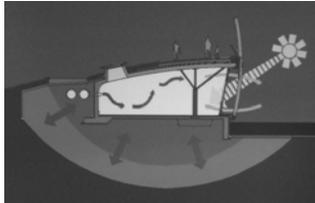


**Zero Energy Development**



Mile End Road Park

**Zero Energy Development**



Zero Energy Development Use of thermal mass of earth to store heat for 6 months

Mile End Road Park, E London



High Thermal Mass at surfaces fairfaced brick, block and plank

Thermal Mass: Materials

- The Concrete sector sees using Thermal Mass as a solution to their embodied energy in cement issue
- but anything that has been fired or is heavy and dense will have a high thermal mass
- Bricks have TM although it is very rarely exploited because they are mostly used on the exterior of buildings

Thermal Mass Materials

- Wood fibre reinforced dense gypsum boards that are very heavily compressed create a reasonable thermal mass without relying on cement or concrete
- 1200 kg/m<sup>3</sup>

Concrete is a major problem.

- ‘Attitudes towards environmental design are definitely getting better, but there are still a lot of misinformed choices being made,’
- Cement alone is responsible for 8% of the global CO<sub>2</sub> production, so if you have to use concrete, you need to make it greener.

Cement Substitution

- You just blend Portland cement with other substitutes like Ground Granulated Blast-furnace Slag Cement (GGBS) and Pulverised Fuel Ash (PFA).
- You can reach up to 30% substitution in structural elements and 70% in non-structural elements.
- Use recycled or secondary aggregates in place of virgin primary aggregates



Acoustics



- Acoustics and airtightness go hand in hand so if you concentrate on meeting Building Regulations Part E and L, which deal with acoustics and heat loss, you will get sound-tightness, airtightness and energy saving as a bonus.
- the choice of materials used in the exterior envelope is also a crucial factor when it comes to Acoustic performance

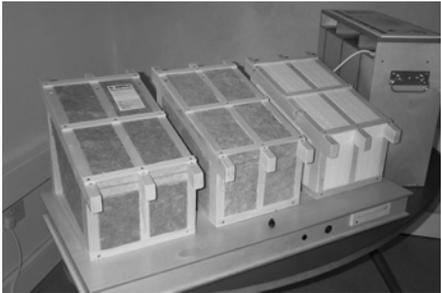
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Acoustics

- Weight is a valuable characteristic when it comes to acoustics and a heavy masonry wall will be able to stop sound waves from passing through it.
- Different arrangements of materials can also effect acoustic performance, so there are wall lining materials on the market that have very small slats on the inner surface with a cavity behind.
- When the sound waves enter through the slot and into the chamber they bounce around until they are absorbed.

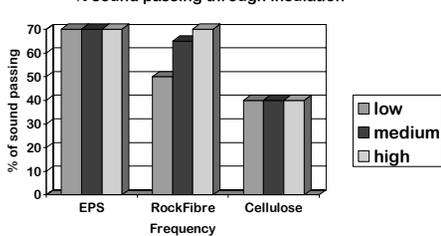
Acoustic Insulation

- Cellulose fibre has been proved to have an excellent acoustic performance, far out stripping that of glass or rock mineral fibre
- highly beneficial in reducing noise pollution internally and externally
- kind to the environment in their manufacture



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% of sound passing through insulation



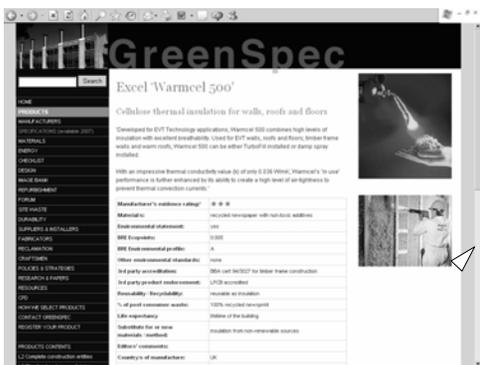
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### Excel Industries SoundCel

- recycled newspaper sound insulation with the added benefit of thermal insulation

### Natural Insulation

- By far the greenest option is to use natural materials:
  - hemp, coconut, cellulose, cotton, wood fibre, sheep's wool,
  - all of which have a decent k-value
  - comparable with glass and rock mineral fibre
- that can provide a good U-value for the external envelope
- Performance maintained when moist unlike glass and rock mineral fibre



### Pavatex's Pavetherm Natural Building Technologies.

### Lightning Protection

- Impact on roof appearance
- Grid of lightning conductor tapes at 10 m. centres (Air termination network)
- Can interfere with paving pattern
- Vertical tapes up tall parts of roofs (air terminals)
- All metalwork connected to or becomes part of air terminal network
- Balustrades, screens, ladders and metal copings



## Green Roof Design Issues

### Green Roof Design Issues:

- Amenity and/or Biodiversity
- Appearance
- Surface colour and solar reflectivity
- SUDS and rainwater regulating
  - Water retention
  - Flood mitigation
- Urban heat island solutions
- Evaporation cooling heat losses

### Amenity v Biodiversity

- EcoHomes and BREEAM encourage recreation of the site on the roof of buildings
  - Intensive roof gardens for people
  - Extensive brown eco-roofs for nature
- Code for Sustainable Homes will try harder

### Appearance

- The 5<sup>th</sup> elevation
- Overlooking by neighbours
- Roofs are usually neglected part of design
- Gravel ballast is common in margins of paved roofs
- Maintenance is often poor
- Leaf litter is a problem in gutters and outlets
- Tenant alterations e.g. adding air conditioning plant spoil it
- Flooded roofs were familiar to Victorians, now all but forgotten
- Living roofs are uncommon in the UK
- Intensive roofs are becoming common and accepted
- Brown roofs are becoming popular in pockets

## Solar Reflectivity & Surface Colour

- White spar chippings in bitumen was the standard spec for built up roofing (J41)
- Solar reflective paint 5 year life
- More common today (J21 J31 J41 J42)
  - Grey paving slabs
  - Gravel ballast
- Living Roofs are replacing some of them
- The albedo of the roof should aim to compensate for the loss of Earth's albedo

## Building Regulation Approved Document Part G

- Government backed out of updating Part G
- Failing to force industry to change by addressing water efficiency,
- we are going to see very little change
- Until the next round of updates
- If they are brave enough to Regulate then
- Code of Sustainable Homes (other buildings later) will start the drive
- albeit a Voluntary Code until spring 2008
- Optional levels of achievement

## Green Roof Spin-off Benefits

- MoD & Defence Estates
  - Camouflage from visual aerial reconnaissance
  - Minimal heat signature for spy planes and satellite thermal imaging cameras
- Clay: electromagnetic radiation absorption
  - Does it work in green roofs?



## Water Demand



- SE England under water stress:
  - especially EofE
- Avoid irrigation: it can be unnecessary
- Capture rainfall in living roof build-up
- Plant drought resistant species

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## SUDS Sustainable Urban Drainage Systems

- We need to be exploring new technologies on the market that can cope with heavy rain more effectively and are kinder to the environment.
- flat green or brown roofs
- Rainwater harvesting from roofs and gutters
- permeable pavement to absorb, hold and slow down rainwater entry to sewers
- divert rainwater away from sewers
- replenish the water table and/or store for reuse

## 'Urban heat island' solutions

- Low thermal mass at the surface helps
- Solar reflectivity helps
- Better insulated building help
- Regular street pattern helps ventilation

## Evaporation cooling

- Evaporation cooling from absorbent construction helps cool the building
  - Good in summer
  - Can work in reverse in winter
- Evaporation cooling from green roofs helps cool roof



## Green Roof Design Issues Resource Efficiency

16/12/2007

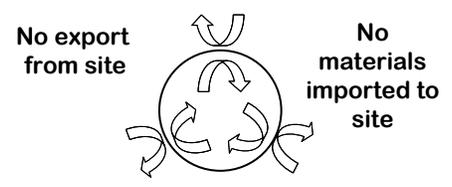
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Other considerations

- Resource efficiency
  - Autonomous sites reuse all arisings on site
- Ballast for lightweight buildings
  - Flat roofs create suction or uplift
  - Ballast helps counteract this force
  - Water or living roofs provide ballast

Site Autonomy



Materials and sourcing

- Site autonomy
  - Clean Gravel from site
  - Secondary aggregates
  - Recycled aggregates
  - Clean builders rubble
- Reclaim reuse and return
- flotsam and jetsam

Modular framed designs

- Walter Segal Method
- Simple low impact foundations



Topsoil & Subsoil Stockpile on site



Green Roof  
wild turf roof from local construction clearance site, gravel margin gutter



Green Roof on walls

Pembrokeshire traditional Hedge Bank

Rubble cavity wall  
Turf mortar draining soil and topsoil  
Turf cap (hedging optional)  
Rainwater  
Back to nature very rapidly

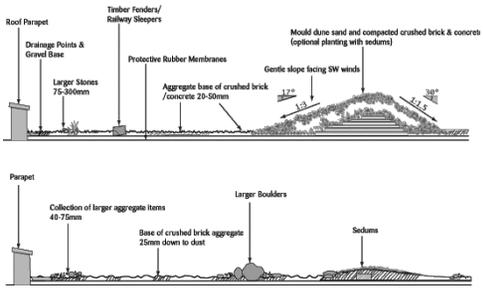


Wild Flowers & Meadow Grass  
Neglected landscape nature takes over Listed Grade I barn



Brown Roofs  
Creekside Visitors Centre Deptford London

**Brown Roofs**



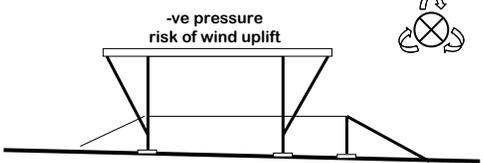
**Brownfield Landscape**

- Derelict Brownfield sites often have more wildlife than Greenfield sites
- To maintain or enhance the biodiversity of the site much can be done with a little care
- Survey the site and check for wildlife: Insects, birds, animals, and lower forms, wild flowers, grasses, etc.



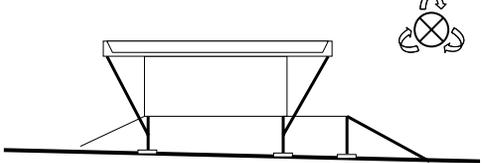
**Brownfield Landscape**  
Creekside Visitors Centre

**Light touch small footprint**



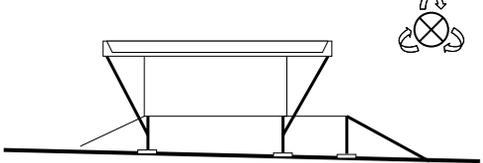
No excavation  
Paving slab foundations  
Flat roof risk of wind uplift

**Light touch small footprint**



No excavation  
Paving slab foundations  
Add water for ballast against wind uplift (top up in summer)  
Thermal Mass, solar protection and evaporation cooling

**Light touch small footprint**



No excavation  
Paving slab foundations  
Add living roofs for ballast against wind uplift  
Thermal mass, solar protection and acoustic insulation



**Green Roof Specification Issues**

**Specification Issues**

- Design Subdivision
- Sub-contracting Issues
- Specification Subdivision
- Specification Embellishment
- Specification Appendix

## Sub-contracting

- NBS Guidance
- 8 Contractual requirements
- 8.1 Contractor's/ Subcontractor's design
- Where responsibility for completing the design of the work in this section is to be placed with the Contractor or a subcontractor see Preliminaries section A30.
- 8.2 Subcontracting
- The specifier may choose a subcontractor or influence the choice of subcontractor in several different ways. See Preliminaries section A30.
- 8.3 Requirements for submission of information
- The specifier may require the Contractor or a subcontractor to submit drawings or other technical information. See Preliminaries section A31.

## Specification: Subdivision

- NBS Building
- Deck: various
- E10 Concrete
- E60 Precast Concrete Decking
  - Plank or beam and block
  - Structural topping
- G20 Timber Decking
- G30 Metal Decking

## Specification Subdivision

- NBS R10 Rainwater Goods
- NBS Engineering
- S14 Irrigation
- S15 Water features
- S17: Rainwater Harvesting
- V91: Electrics & Lighting
- W52: Lightning protection

## Design: subdivision

- B&D Build and Design Contracts
  - Inappropriately named: D&B Design & Build
- Employer's Requirements: often poorly written
  - Design Substitution occurs
  - QS takes on design responsibility without knowledge, understanding, authority or PI Insurance
  - Call for 'Value Engineering' but concentrates on 'Cost Cutting'
- Package subdivision
  - Package interface and co-ordination:
  - bases and upstands, loads, Waterproofing /green roof, services interfaces, following trades
  - Guarantee integrity
- Specification Substitution by contractor/sub-contractor
  - Equivalency needs policing

## Specification: Subdivision

- NBS Building
- Roofing:
  - with thermal and acoustic insulation
  - without solar protection
- J21 Asphalt roofing
- J31 Liquid applied roofing
- J41 Built up roofing
- J42 Single layer roofing

## Specification Subdivision

- NBS Landscape or NBS Building
- J44 Pond linings
- Q10 Kerbs/ Edgings/ Channels/ Paving accessories
- Q23 Gravel/ Hoggin/ Woodchip roads/ pavings
- Q28 Topsoil and growing media (compost)
- Q30 Seeding/ Turfing
- Q31 External planting
- Q35 Landscape maintenance
- Q37 Green roofs
- Q55 External decks, boardwalks and pergolas

## Specification Services

- NBS Subscription services:
  - NBS Building £1045+VAT per annum
  - NBS Landscape £1045+VAT per annum
  - NBS Engineering £1045+VAT per annum
- NGS Specification downloads:
  - Soon from GreenSpec
  - £1/download

## Specification: Subdivision

- NBS Building
- D20 (Reclaimed soils)
- L30 Balustrades
- N25 Safe Access Systems

## NBS Clause example

- EXTENSIVE GREEN ROOF: [\_\_\_\_\_]
- Roof type: [\_\_\_\_\_].
- - Substrate: [\_\_\_\_\_].
- - Slope: [\_\_\_\_\_].
- Waterproofing: [\_\_\_\_\_].
- Thermal insulation: [\_\_\_\_\_].
- Protection: [\_\_\_\_\_].
- Moisture control layers: [\_\_\_\_\_].
- Growing medium: [\_\_\_\_\_].
- - Depth: [\_\_\_\_\_].
- Vegetation: [\_\_\_\_\_].
- Accessories: [\_\_\_\_\_]

### Specification: Embellishment

- NGS GreenBuildingSpecification
- A90 Performance Specification
- A38 Waste & Resource Efficiency
- A39 Packaging waste
- D20 Excavation arisings for reuse
- Q28 Topsoil, Compost, Mulch, Top Dressings
- Q29 Landscape arisings for reuse
- Z10 Timber Stewardship (FSC)
- Z11 Metal Stewardship (soon)
- Z40 Stone Stewardship (soon)

### Specification Appendix:

- **Manufacturers & Suppliers**
  - Local, county, regional, national
- **Applicators & Installers**
  - Local, county, regional, national
- **Material Exchange**
- **Take Back schemes**
- **Recycling companies and opportunities**



# Roof Materials & Construction

### Roof Construction:

- **Roof:**
  - Structure
  - Falls, skirting and upstands
  - Thermal & Acoustic Insulation
    - Cold bridge reduction
- **Waterproof membrane**
  - Rainwater outlets and access
- **Ballast and solar protection**
  - Replaced by Living Roof

### Supporting Structure

- **Sedums has own water storage capacity so little is provided in build up:**
  - Relatively little extra weight
- **Grass turf soil: greater extra weight**
- **Water reservoir boards and soil retain water: extra weight**
- **load-bearing capacity increased accordingly**

### Falls

- **Structural deck to falls**
  - Structural engineers often not happy
  - Insulation constant thickness
  - Ideal solution for insulation
  - Soffit to falls may look odd if exposed
  - Suspended ceiling accommodates slope



### Falls



- **Structural deck level**
  - Insulation to falls: varying thickness
  - Insulation cut at factory and labelled
  - Insulation jigsaw onsite: marked pieces
  - Insulation minimum thickness to meet U value
  - but often designed to meet average performance

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### Falls



- **Due to deflection and creep**
- **Spans will sag in middle**
- **generate low points**
- **Often do not coincide with outlets**
- **Solution increase falls to ensure minimum falls are obtained**

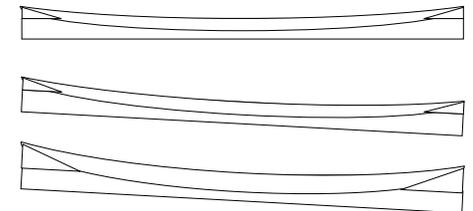
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### Falls



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### Falls

- Roof structure/insulation best laid to falls to carry away excess water
- J31 Liquid Applied Roofing
- Can be laid flat (no falls)
- but reliant upon symphonic drainage
- Needs fast flows of excess water
- Not applicable to living roofs

### Cold bridge reduction

- Two layers thermal insulation, staggered to reduce cold bridging by rainwater
- Take care to reduce cold bridges at:
  - Abutments
  - changes of fall
  - outlets

### Waterproof membranes

- H&S is driving bonding methods and materials choices without understanding the alternatives
- Hot applied Asphalt and Liquid Applied Membrane
- Out:
  - Hot adhesives bonding
  - Hot flame
  - Hot air
- In:
  - Cold bonding methods
  - Synthetic solvent based High VOC
  - Vulcanising (solvent?)
  - Peel off self adhesive strip (waste): ???



### Upstand & Skirting



- Accommodate living roof build up
- Skirting: 150 mm. above finished surface plus living roof thickness
- Balustrade: 1100 mm. above finished surface
- Minimum 2 rainwater outlets per roof to avoid flood risk from blockages

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### Roof insulation



- Cold, warm or inverted roof insulation
- Keep insulation dry to maximise performance
- Keep structure warm to maximise thermal mass
- Water resistant/excluding materials
- Load-bearing materials

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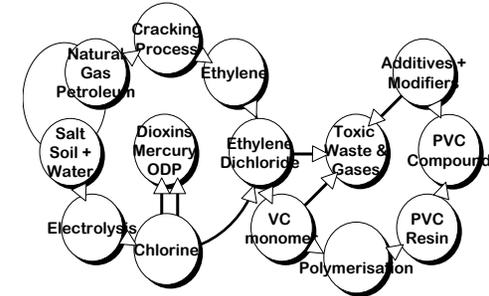
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### Waterproof membranes

- Gorillas and Lipstick
- Why have a green roof and violet membrane?
- Choose low environmental impact membrane
- Avoid PVC: Petro-chemical, Chlorine, polymer migration, phthalates, toxins, dioxin, ozone depletion, hazardous waste, landfill leaching
- Consider EPDM and TPO
- See GreenSpec Materials Flat roofing page

### PVC manufacturer



### Rainwater outlets

- Minimum 2/roof in case of blockage
- Could exclude or trap leaf litter to avoid blockages
- Inspection and rodding from surface
- Connect to RWH

### Rainwater harvesting

- Pass all water through RWH filter
- Centrifugal action in circular down pipe
- Fine mesh filter in pipe wall
- Leaves moss and debris to drain
- Concentric chamber to collect water
- Water to storage chamber
- Pump back to grounds irrigation, WCs, outdoor tap,

### Normal Ballast

- Traditionally 20-40 mm. dia. well rounded, smooth aggregate
- 50 mm. thick layer on roof
- At margins and changes in falls
- Suffers from wind scour and build up leading to blowing over roof parapets
- Crows have learned to drop them off roofs canary wharf towers too



## Green Roof Materials & Construction

### Green Roof Construction

- Living roof classification and types
- Build-up
- Soil and substitutes
- Seeding and Turf
- Planting Choices
- Landscape finishes
- Installation
- Maintenance

### Living Roof NBS Classification:

- Intensive Roof Gardens
  - Green Roof
  - Grasses, planting and trees
  - Irrigated
  - Public Access & Amenity
  - Intensive maintenance
- Simple Intensive
  - Visual amenity to surrounding buildings
- Extensive
  - For nature
  - Brown Roof
  - Drought Tolerant species and Sedums

### Living Roof Options:

- Flat
  - normally
- Pitched
  - Construction safety and practicality issues
  - Water retention issues
  - Maintenance safety and practicality issues
  - Avoid slippery grass consider sedum
- Modular Tray systems

### Green roof build-up layers and functions

- Roof build up to waterproof membrane then:
- Root Barrier (often copper based)
- Protection Layer (sharp tool resistant)
- Separation Layer
- Moisture Retention Mat (Reservoir board)
- Drainage Layer
- Filter Membrane
- Growing Medium
- Vegetation Blanket
- Anti-Erosion Mat

### Q28 Growing Media

- Green Roof:
  - TopSoil
  - Proprietary soil substitutes
  - Recycled or Secondary aggregates
  - Clean crushed building site rubble
  - Excavation arisings with compost

### Q28 Compost:

- High recovered content from green waste composting
- Good for water retention
- Mulch, Top Dressing, etc.
- WRAP/NBS/BALI/CA standards
- Certification label
- Supplier database website

### Planting choices

- Grass and Grasses
- Plants
  - Avoid:
    - Exotic imports
    - Require irrigation
  - Consider
    - Nectar Bars
    - Indigenous species
      - by postcode
    - drought tolerant species (indigenous species often are)
    - Sedum

Q30 Seeding and Turf

- Pre-seeded rolls
- Turf
- Grass, Gasses,
- Species mix
- Indigenous species
- Drought resistant mix
- Indigenous wild flower meadow
- Natural inhabitation

Pre-seeded or pre-planted rolls

- Off-shelf solution
- Bespoke solution
- Grown in fields or conservatories
- Rolled up, delivered and unrolled
- indigenous species by Postcode
- Sedum
- Plants, grasses, turf
- Spray on sedum in papier mache

Q31 Plant packaging

- Paper seed packets: Compostable
- Plant pots, trays and bags
- Bio-plastics: Compostable
- Biodegradable PE Polyethylene
- Collect and recycle
- Agricultural Polyethylene is regularly recycled into black bin liners and DPM

Q31 Planting

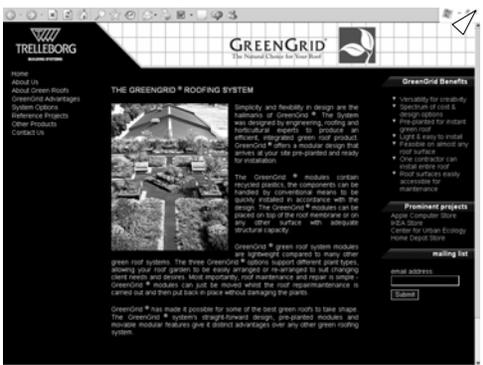
- Support pollinators: indigenous species
- Drought Resistant: often means indigenous or visa versa
- Victorians imported thirsty plants needing watering or that need heat, wind and weather shelter: greenhouses
- Sedum/succulents are drought resistant
- but only 3 are indigenous

Modular Trays

- Preformed robust plastic trays
- Approx. 900 x 900 mm. modular easy handling
- Sit on roofing membrane
  - (polymer migration potential)
- Relatively light when full
- Irrigation fitted if required
- Pre-planted for instant green roof
- Delivered on wheeled stacking rack
- Unskilled labour on site
- No site waste
- Easily accessible to maintain roof:
  - move trays, access, maintain, fix, replace trays

Modular Fill

- Postcode indigenous planting offered
- Grass and grasses
- Sedum
- Mulch
- Vegetables
  - Educational gardens for schools
  - Community gardening allotments on roofs
- Herbs
- Excavated gravels reclaimed from site
  - Reused in trays and returned to site
  - (Transport, fuel, emissions, congestion, storage issues)
- Clean builders rubble with 15-20% soil
- Redesign landscape by moving modules



Recycled landscape materials

- Recycled timber mulch (Q23)
- Recycled stone and glass mulch (Q23)
- Recycled aggregates drainage media
- Recycled plastics wood substitutes as edgings, furniture, decking (Q10, Q50 & Q55)
- Recycled glass: glass sand

Reclaimed and reused landscape materials

- Hardwood sleepers: many applications
- Hardwood from sleepers: many uses
- Bricks: reuse as pavers
- Stone flags: reuse as paving flags
- Turf: regular or Wild Turf

## Q Paving choices:

- Mulch (Q23)
  - recycled wood
  - recycled crushed brick or stone
  - Tumbled glass
- Path
  - Reclaimed bricks or stone flags (Q25)
  - Recycled crushed brick or stone (Q23)
  - Recycled glass sand (Q23)

## Installation

- Follow:
  - BSI Code of Practice or British Standards?
  - CEN or ISO standards?
  - German FLL standard
  - Agrément certificate (observe any restrictions)
  - Manufacturer's recommendations
  - Industry best practice
  - Identify any conflict/contradiction and seek advice
- Manufacturer approved/trained specialist labour
  - Local companies and labour?
- Integrity: for Guarantee or warrantee
  - Manufacturer inspections

## Q35 Maintenance

- Intensive Green Roof
- irrigation systems
  - last resort
- Infrequent trimming of wild gardens
- Composting provision for cuttings
- Occupant kitchen waste via 'Rocket'
- Wormaries

## R10 Rainwater outlets

- Minimum 2/roof in case of blockage
  - Dead seagull rainwater blockage test
  - Should exclude or trap leaf litter to avoid blockages
- Must avoid fine materials loss
- Must permit water retention
- Must permit excess water release
- Inspection and rodding from surface
- Connect to RWH

## Pitched Roof application:

- Difficult working conditions
- CDM restrain latch way for construction and maintenance
  - Spec NBS N25
- Sedum seed sprayed on in a Papier Mache mix, composts down and disappears
- Cutting grass on slope not easy, Dermott!
- walk up, sheep or goat access

## S17 Rainwater harvesting

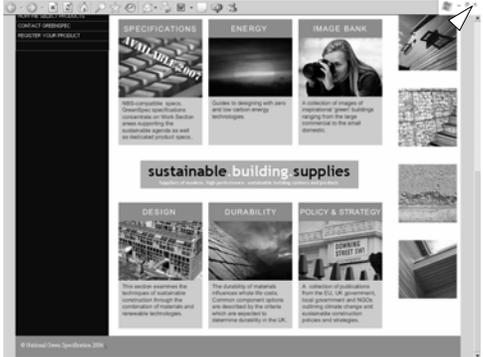
- Pass all water through RWH filter
- Centrifugal action in circular down pipe
  - No square down pipes
- Fine mesh filter in pipe wall
- Leaves, moss and debris to drain
- Concentric chamber to collect water
- Water to storage chamber under pavement
- Pump back to landscape irrigation



# GreenSpec Roofs & Green Roofs

## GreenSpec Website

- Search
  - find the Goggle but GreenSpec only
- Product & Material Pages
  - 400 of 6000 identified
- Manufactures
- Specifications
- Material
  - Environmental characteristics comparison pages
  - System Guides
- Renewable Energy Services Guides
- Sustainability Checklist
  - 180+ pages in file-based chunks
- Code for Sustainable Homes
- Low Carbon Homes
- Design Guidance Articles
- Image Bank
  - 2 Buildings with Green Roofs
- Refurbishment
  - Installation in existing flat roof including GreenRoof
- Forums Questions & Answers
- SiteWaste
- WasteCost® lite calculator
- Durability and Whole Life Cost Guides
  - 2 flat + Pitched
- Suppliers
- Fabricators
- Reclamation
- Craftsmen
- Government policy & strategies: National, Regional & Local
- Research & Papers
- Resources: Useful Links page
- CPD
  - seminar list
- How GreenSpec select products
- Contact GreenSpec
- Register your product
- EcoBuild GreenShoots



**Products**

GreenSpec  
www.greenspec.co.uk

- Waterproof membranes
- TPO or EPDM, no PVC
- <http://www.greenspec.co.uk/html/products/list524.html>
- E.g. Product
- <http://www.greenspec.co.uk/html/product-pages/ecoseal.php>

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**Specifications (soon)**

GreenSpec  
www.greenspec.co.uk

- <http://www.greenspec.co.uk/html/specifications/specificationscontent.php>

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**Materials**

GreenSpec  
www.greenspec.co.uk

- <http://www.greenspec.co.uk/html/materials/flatroofs.html>

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**System Guides**

GreenSpec  
www.greenspec.co.uk

- Green Roofs 1 Types & Construction
- <http://www.greenspec.co.uk/html/materials/greenroof1.html>
- Green Roofs 2 Design Guide
- <http://www.greenspec.co.uk/html/materials/greenroof2.html>

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**Image bank**

GreenSpec  
www.greenspec.co.uk

- Pines Calyx
- <http://www.greenspec.co.uk/html/imagebank/pinescalyx.html>
- Earth Centre Doncaster
- <http://www.greenspec.co.uk/html/imagebank/earth.html>
- Integer House BRE
- <http://www.greenspec.co.uk/html/imagebank/integer2000.html>

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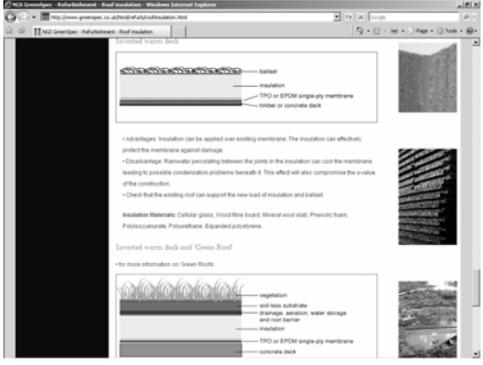
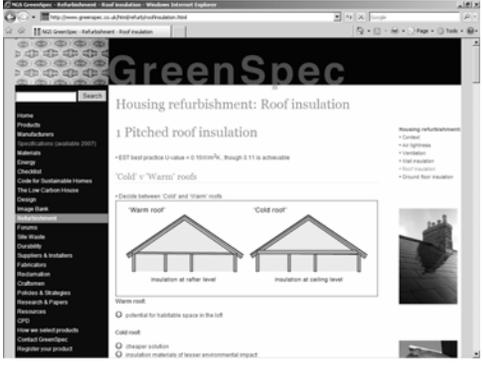


**Refurbishment**

GreenSpec  
www.greenspec.co.uk

- Existing roofs
  - Structural capacity for green roof
  - Insulation
- <http://www.greenspec.co.uk/html/refurb/roofinsulation.html>

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### Sustainability Checklist: J Waterproofing

- <http://www.greenspec.co.uk/html/checklist/J-Waterproof.html>
- J21 Asphalt
- <http://www.greenspec.co.uk/html/checklist/J-Waterproof.html#J21>
- J31 Liquid Applied
- <http://www.greenspec.co.uk/html/checklist/J-Waterproof.html#J31>
- J4 Green Roof (Q37)
- <http://www.greenspec.co.uk/html/checklist/J-Waterproof.html#J4>
- J41 Built up roofing
- <http://www.greenspec.co.uk/html/checklist/J-Waterproof.html#J41>
- J42 Single layer
- <http://www.greenspec.co.uk/html/checklist/J-Waterproof.html#J42>
- J44 Pond lining
- <http://www.greenspec.co.uk/html/checklist/J-Waterproof.html#J44>



### Durability & Whole Life Costs

- Single Ply roofing
  - <http://www.greenspec.co.uk/html/durability/membranes.html>
- Liquid applied roof waterproofing
  - [http://www.greenspec.co.uk/html/durability/roof\\_waterproofing.html](http://www.greenspec.co.uk/html/durability/roof_waterproofing.html)



## Green Roof Campaign

### Green Roof Campaign Petition

- [www.livingroofs.org/livingpages/greenroofcampaign.html](http://www.livingroofs.org/livingpages/greenroofcampaign.html)
- Lobbying The Government For A Policy On Green Roofs In The UK
- Sponsored by Permanite part of the IKO Group
- We hope you will take the time to review the aims, register your support and pass on the details to friends and colleagues.

## Campaign Overview:

- The Green Roof Campaign aims to raise support from the construction industry, politicians, local government, scientists and the general public for a solid Government policy on green roofs in the UK.
- The Green Roof Campaign will also canvass industry opinion as to what such a policy should contain.

## Goal Of The Campaign:

- It is the aim of the Green Roof Campaign to encourage the UK Government to deliver a positive policy for green roofs and to educate the nation about the benefits of green roof technology.

## Sign The Petition

- For further information and to register your support for the Green Roof Campaign by signing the online petition
- [www.livingroofs.org/livingpages/greenroofcampaign.html](http://www.livingroofs.org/livingpages/greenroofcampaign.html)