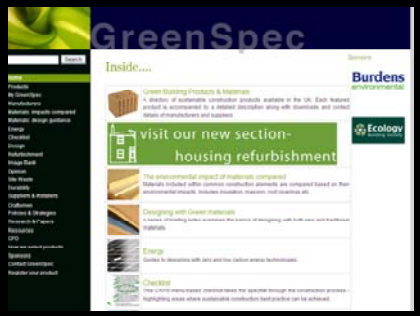


GreenSpec
www.greenspec.co.uk

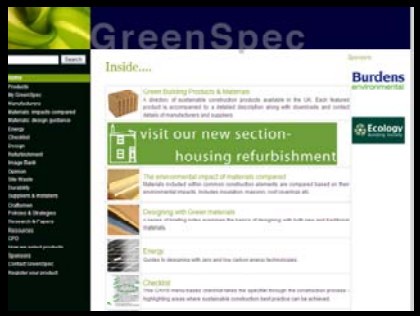
(21) Other External Walls

CI/SfB (21.1) Load-bearing

(21.3) Non Load-bearing

LSBU Tech & Env 2 Lecture

- Domestic, Small & Medium size buildings
- Construction methods, materials, services and systems
- External walls



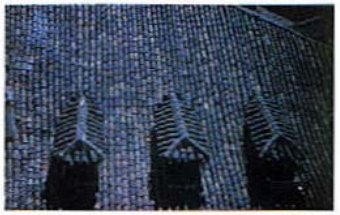
GreenSpec
www.greenspec.co.uk

Performance Requirements

Principles of Element Design

THIRD EDITION

PRINCIPLES OF element design



Peter Rich & Yvonne Dean

Architectural Press

ARCHITECTURE/DESIGN

PRINCIPLES OF element design THIRD EDITION

Peter Rich & Yvonne Dean

- **Unique in its approach to detail design**
- **Invaluable for both students and practising architects, builders and surveyors**
- **Completely updated in a convenient reference sheet format**

The construction of buildings is learnt through experience and the inheritance of a tradition in forming buildings over several thousand years. Successful construction learns from this experience which becomes embodied in principles of application. Though materials and techniques change, various elements have to perform the same function. **Principles of Element Design** identifies all the relevant elements and then breaks these elements down into all their basic constituents, making it possible for students to fully understand the given theory and principles behind each part. As all building projects are subject to guidance through the Building Regulations and British Standards, this book gives an immediate reference back to relevant information to help practitioners and contractors identify key documents needed.

Peter Rich AA Dipl (Hons) Architect, started his career with 14 years' experience as a qualified architectural technician. He then joined the AA School of Architecture, working with Bill Allen and John Bickerdike after his graduation, later becoming a partner of Bickerdike Allen Rich and Partners. He also taught building construction at the Bartlett School of Architecture, University College London, and architectural design at the Polytechnic of North London. He now acts as a Consultant.

Yvonne Dean B.A. (Hons) B.A.(Dipl.) RIBA, is an architect, energy consultant and materials technologist. She also has 15 years' experience as a lecturer, travels widely and is a guest lecturer at many universities. She pioneered an access course for Women into Architecture and Building, which has been used as a template by others, and has been instrumental in helping to change the teaching of technology for architects and designers.

Architectural Press
An imprint of Butterworth-Heinemann
http://www.bh.com

ISBN 0-7506-3113-9
9 780750 631136

Wall Actions

- Gravity: downward pull
- Wind: Motive, Destructive, Penetrative
- Rain: Moisture deposition, penetration
- Snow: Moisture deposition, loading
- Moisture vapour: permeation, condensation, insulation impaired, material degredation
- Sun: Temp variation, thermal movement, heat gains, Chemical decomposition
- Dirt and Dust: infiltration, deposition, surface pollution
- Chemicals: corrosion, disintegration, decomposition
- Sound: Noise nuisance, from within and from without
- Attack: Manual, Ballistics, Bomb Blast
- Thermal: heat loss, radiant coolth, condensation, stack effect

Wall Reactions

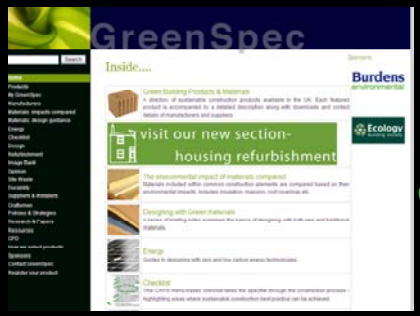
- Gravity: Support & restraint
- Wind: rigidity, resilience, sealing, air tightness layers and detailing
- Rain: deflection, impervious skin, absorption and drainage, sealing
- Moisture vapour: resistance, hygroscopicity, permability, breathing, moisture mass
- Snow: deflection, impervious skin, absorption and drainage, sealing
- Sun: movement joints, insulation, shielding, invulnerable materials
- Dirt and Dust: repulsion, exclusion, sheilding, cleaning
- Chemicals: invulnerable materials, exclusion,
- Sound: Insulation, absorption, acoustic mass, separation, isolation,
- Attack: toughness, lamination, edge restraint, edge protection
- Insulating: thermal insulation, thermal mass, U value, G value, cold bridge avoidance/minimisation

Principles of Element Design

- Appearance
  - Interior and exterior materials and finishes
- Structural strength and stability
  - Load-bearing
  - Wind resistance
- Weather barrier
  - Rain, snow, wind, sun,
  - dirt dust pollution
- Durability
  - Moisture resistance, frost, mould
  - Moisture Mass & Hygroscopicity
  - Ozone and sunlight degradation
- Thermal Performance
  - Heat Resistance: loss and gain
  - Condensation Avoidance
  - Airtightness
  - Avoidance of Cold Bridges
  - Thermal Mass
- Movement
  - Structural , thermal, moisture, Frost
  - Chemical

Principles of Element Design

- Acoustic Performance
  - Resistance, absorption
- Fire Performance
  - Surface spread of flame
  - Fire Resistance
- Security
- Inspection and maintenance
  - Inside & out
- Pest infestation
  - Termites,
  - Termite Barriers
- Rising damp
  - Barriers
  - Capillary Attraction
  - Hygroscopic or Hydrophobic
  - Frost action
- Health
  - Moisture Mass
  - Low allergy materials



GreenSpec

www.greenspec.co.uk

Weather Envelope

Absorbent – Repellent – Open Joint Panelled Masonry – Curtain Wall – Rainscreen

GreenSpec
www.greenspec.co.uk

LCGB: Low Carbon Green Buildings

Brian Murphy (GreenSpec)

Another GreenSpec CPD to download soon

www.greenspec.co.uk

Wind

Affects on buildings

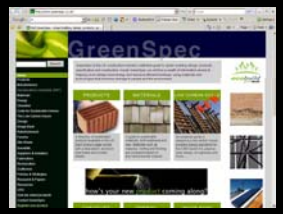
Another GreenSpec CPD to download soon

www.greenspec.co.uk

Airtightness & Testing

A94 on-site testing
Regulation, Energy loss, Testing, Sealing, Construction

Another GreenSpec CPD to download soon



GreenSpec
www.greenspec.co.uk

Airtightness & Building Elements

12 of 25 Air Movement in Buildings

Another GreenSpec CPD to download soon

www.greenspec.co.uk

Conduction
Convection
Radiation
Conduction

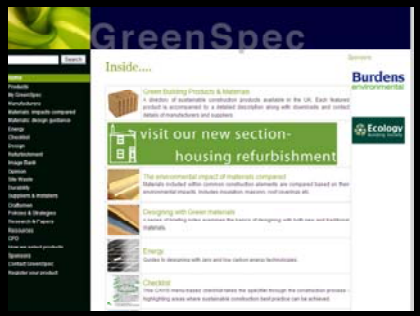
Another GreenSpec CPD to download soon

Carbon Neutral or very low carbon building materials

- Straw bale
- Hemp-lime
- Rammed Earth
- Unfired Clay Brick
- Unfired Clay Block
- Chalk Blocks
- Limecrete

Lower carbon building than normal

- Unfired clay brick



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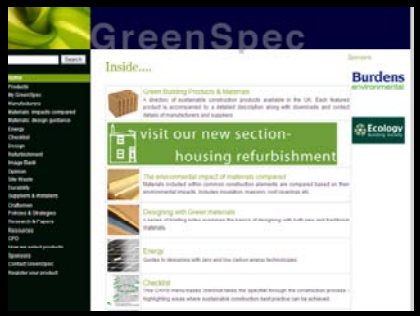
www.greenspec.co.uk

EcoConcrete

- In case you have no other choice
- Cement Replacement with GGBS and PFA and Aggregate Substitution with recycled and secondary aggregates
- W http://www.aggregain.org.uk/

"Crops in construction handbook"

- CIRIA 2004
- Summary and sample the first chapter or so
- http://www.ciria.org/acatalog/C614.html
- useful background information in particular on the properties needed from crop-based materials.



GreenSpec

www.greenspec.co.uk

(21.1) Gj3
(21.3)

CAWS F42
Uniclass P6213

Straw Bale Walls

CAWS F42 Straw Bale Walling Systems

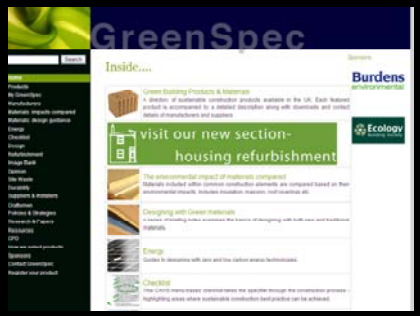
G Large Block, Panel work, j vegetable and animal fibre 3 Straw

GreenSpec
www.greenspec.co.uk

F42 Straw Bale Walls

F42 Straw Bale Walling Systems

Another GreenSpec CPD to download soon



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(21.1) Eq9
(21.3) Ff9 Pj9

CAWS ____
Uniclass ____

Hemp-Lime Walls

E Insitu, q9 other lime aggregate mixes
F Blockwork, f9 other materials precast with binder
P Thick coating work j9 other vegetable and animal fibre

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www.greenspec.co.uk

Hemp-Lime Construction

On-line CPD topic

Another GreenSpec CPD to download soon

Hemp-Lime ‘Cottage Industry’

- Suffolk Housing Association
- Architects Ralf Carpenter of Modece
- Experimental comparison project
- Significantly out performs conventional walls with better U value
- U and k values are not enough to quantify characteristics, next is G values
- Not fully understood outside small circle
- Potentially CO_2 negative: Sequestration

DRAFT

FOR YOUR EYES ONLY NOT TO BE CIRCULATED TO ANYONE ELSE

"Hempcrete"
Building Construction with Hemp Composites

A Technical and Design Guide

By

Rachel Bevan and Tom Woolley

Hemp-lime: Design Guide

- NNFCC National Non-food crops centre
- Funded research project:
  - Lhoist, Lime Technology Ltd. Hemcrete
  - Queens University Belfast: Tom Woolley
  - NGS GreenSpec: Brian Murphy
  - Modece: Ralph Carpenter
  - Bath Uni: Peter Walker
- Output:
  - Architects Design Guide
  - Specification in guide and on GreenSpec site

limetechnology

Sustainability continues to be the issue of our generation and a critical factor in the design, specification and construction of buildings. With the UK signing up to the Kyoto Agreement to tackle the greenhouse effect, one of the key sustainability drives now focuses on the reduction of CO_2 emissions.

In the UK, the construction and use of buildings accounts for over 50% of the carbon dioxide produced. Studies have shown that up to 200kg of CO_2 is emitted in the production of each square metre of walling for houses alone – equating to 40 tonnes for the walls of a typical house.

To significantly reduce this figure, Lime Technology has launched Tradical® Hemcrete®, a new product innovation of cast in situ hemp-lime walling.

Created in partnership with Lhoist UK Castle Cement and Hemcore, three of the world's leading authorities on lime and hemp based products, Tradical® Hemcrete®, often generically known as Hempcrete, can actually reverse the damaging effects of greenhouse gases by locking up harmful CO_2 emissions within wall construction.

It comprises a unique blend of specially prepared hemp shiv (Tradical® HF) and a special lime based binder (Tradical® HB); which together form a bio-composite building material. The hemp, which forms the key element in these products, is grown and havested in the UK, as illustrated.

Helping to reverse the damaging effects of greenhouse gases, Tradical® Hemcrete® locks up around 110kg of CO_2 per m^3 of wall and provides one of the best value materials for low impact, sustainable and commercially viable construction.

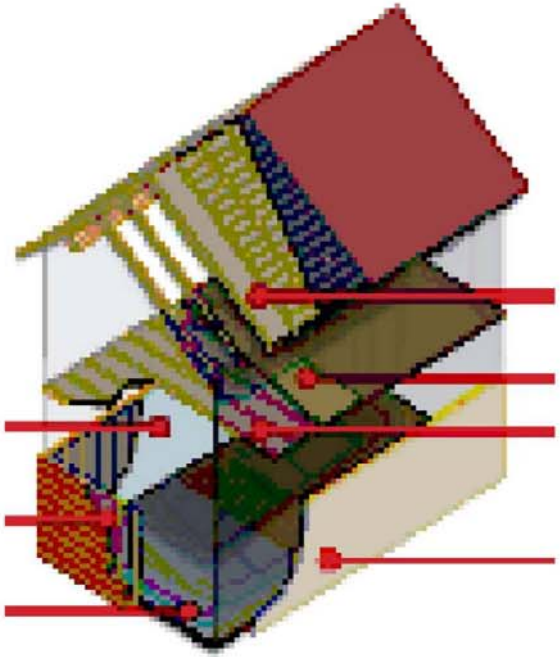
Produced mainly from renewable sources, Tradical® Hemcrete® is mixed on site for fast track construction and delivers high levels of insulation, airtightness and vapour permeability. It is spray applied on site using a shuttering system to create the walls.

Cast in situ walling - please scroll down this page for further information

Downloads - please scroll down this page for further information

Lime Construction Products Assoc

Hemp and lime



Hemp-lime ‘Industrial scale’

- UK Manufacture
- 3 years of R&D & Marketing
- 50% increase 2006
- 200% increase 2007
- £1.5m turnover
- Growth potential Exponential
- Market share: minute but growing rapidly
- Many advantages to understand exploit and compete
- Government interested

Hemp-lime: Violet credentials

- Hemp: CO_2 –ve: Sequestration
- Lime: low CO_2 (compared to Cement)
- Cement: high CO_2
  - for fast initial set and long term strength (blockwork standard)
- Aluminium high CO_2: add to cement for reaction 'aircrete' effect

Hemp-lime

- Green Architects
- Violet Architects with occasional green buildings

Carbon Negative material

- Hemp shiv used as an aggregate and lime as a binder in a limecrete like mix
- Hemp is a rapid growth plant which sequestrates carbon from the atmosphere during photosynthesis whilst growing
- Lime is an adhesive created at lower temperature than cement and is recyclable and reusable

Rammed insitu Construction

- Walls
- Light timber frame
- Formwork both sides of wall
- Fill formwork around frame with insitu hemp-lime
- Rammed from above

Sprayed insitu Construction

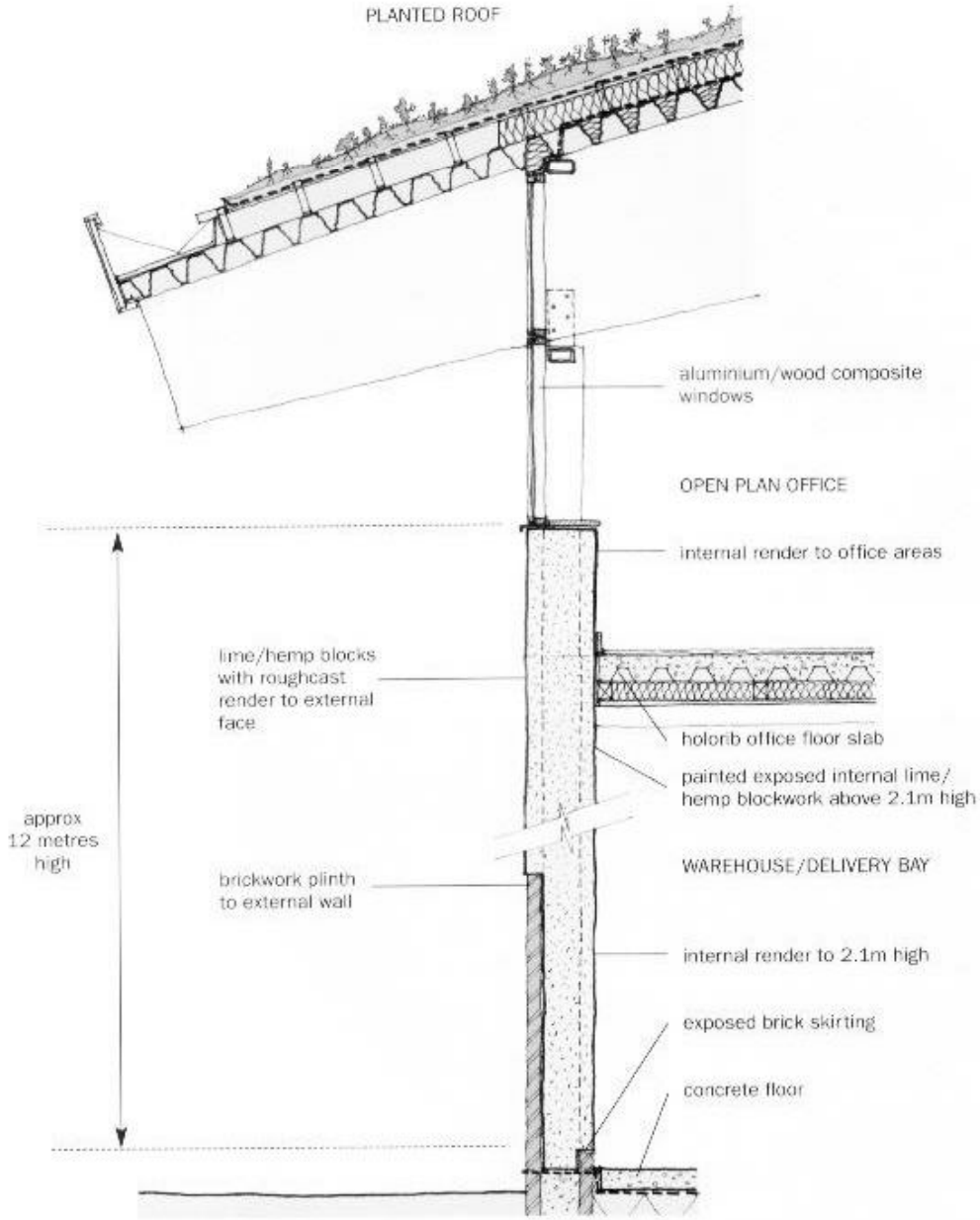
- Walls
- Light timber framing
- Backing board one face of wall only
- Setting out strings
- spray hemp-lime onto board
- build-up to required thickness
- Level off and roughen surface for finish

Impressive insulating properties

- Creates monolithic airtight construction
- No heat loss through air leakage
- No cold bridges
- Hygroscopic breathing wall
- Moisture mass and moisture lag
- Ordinary U value
- Decrement gives exceptional insulation properties
- Thermal mass and thermal lag

Blockwork Construction

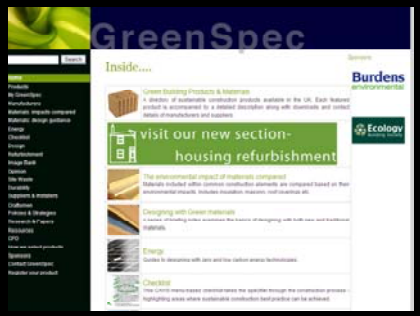
- Hemp-lime blockwork solid walls
- Hemp-lime blockwork diaphragm walls
- Cavity filled with insitu hemp-lime thermal insulation at a lower density
- Outer skin brickwork for weathering and toughness
- Inner face hemp-lime, lime or clay plaster
- Outer face hemp-lime or lime render



Section through a hempcrete wall proposed for Adnams Brewery in Suffolk; there is a section of brickwork at the lower external part of the wall; the wall will be 500mm thick, made up of two courses of hemp block and a hempcrete mix between and around steel columns. (Drawing: Aukett Fitzroy Robinson Architects)

Proprietary Hemp-lime Blocks

- Hemp-lime blocks not quite yet up to BS for concrete blocks minimum 2.8 kN/mm2
- Manufacturer experimenting with recipe
- Adding cement (high embodied energy) for initial set and ultimate strength
- Also adding aluminium (high embodied energy) to cement in mix matrix to obtain foaming function used in 'Aircrete' blocks
- Potentially carbon negative material moves towards carbon neutral or carbon positive

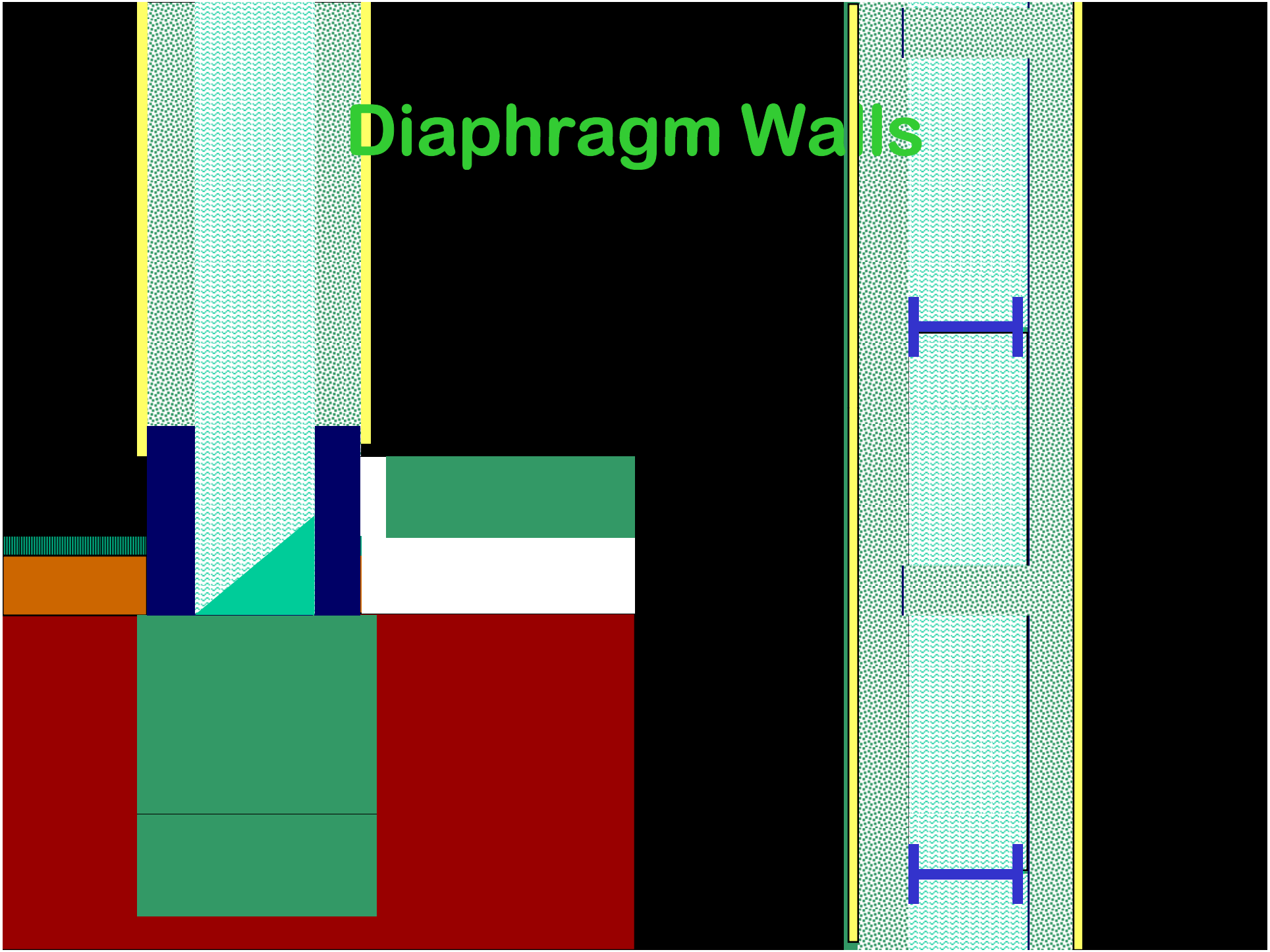


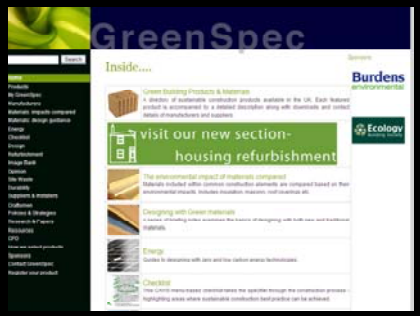
GreenSpec
www.greenspec.co.uk

Diaphragm Walls

- wide cavity walls
- with diaphragm walls linking inner and outer leaf
- Cavity empty or fully filled with insitu insulation grade hemp-lime mix
- Ideally on eco-concrete foundation

Diaphragm Walls





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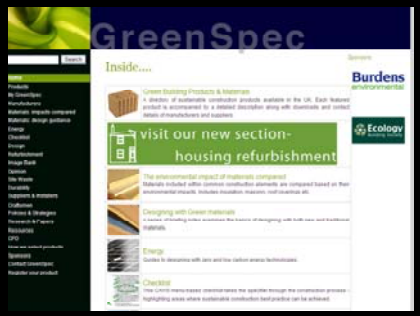
MMC Hemp-lime

- System with timber picture frame and insitu hemp-lime infill
- Factory production
- Site Assembly
- External walls infill panel to framed building



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www.greenspec.co.uk

Rammed Earth Walls

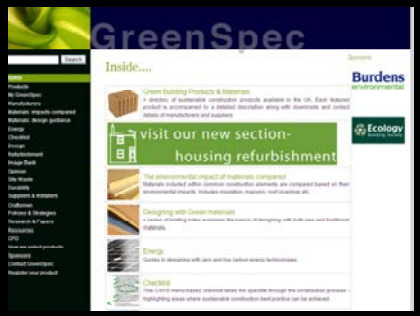
CI/SfB (21) External Walls

(22) internal Partitions

GreenSpec
www.greenspec.co.uk

Rammed Earth Walls

Another GreenSpec CPD to download soon



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www.greenspec.co.uk

Rammed Earth

- W http://en.wikipedia.org/wiki/Rammed_earth
- W http://products.ihs.com/BRE-SEO/ep62.htm
- W http://www.greenspec.co.uk/html/imagebank/eden.html

Training Opportunities

- LILI Low Impact Living Initiative
- cob building
- http://www.lowimpact.org/unstone_course_outline_cob_building.htm

UK Eco-material Market: Rammed earth walls

- Bath University, BRE & others,
- Peter Walker Author
- But BRE CfSC Centre for Sustainable Construction regard this construction as A* = irrelevant
- BRE Published Designer's Guide
- Market share: 5+ buildings + Self-build: growing quietly

Contemporary examples include:

- Eden Project visitors' centre in Cornwall
- AtEIC building at CAT in Powys
- Genesis Project in Somerset
- Rivergreen Centre at Aykley Heads in Durham
- Pines Calyx conference centre Dover

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- Eden Project visitors' centre in Cornwall
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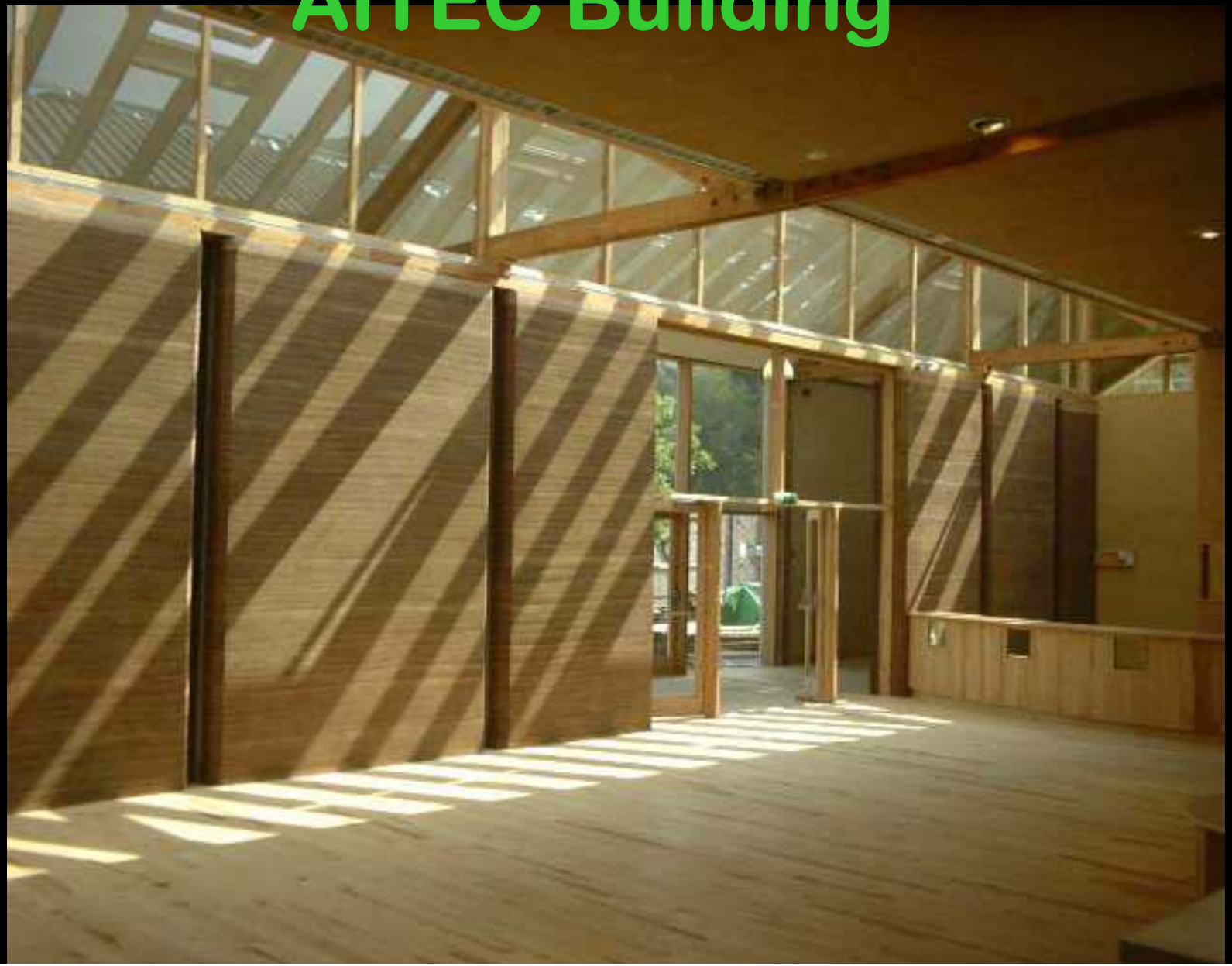
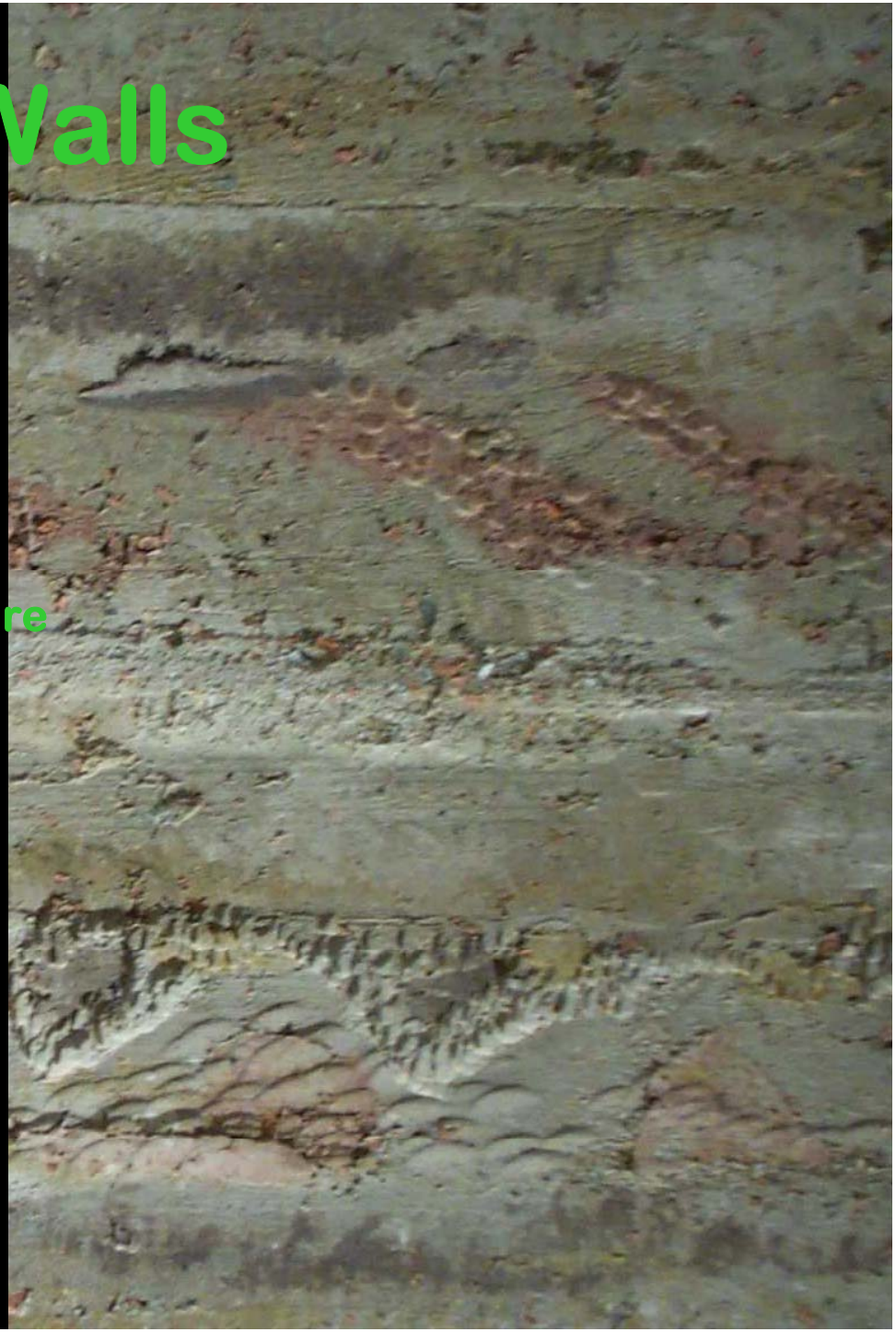
Centre of Alternative Technology
AITEC Building

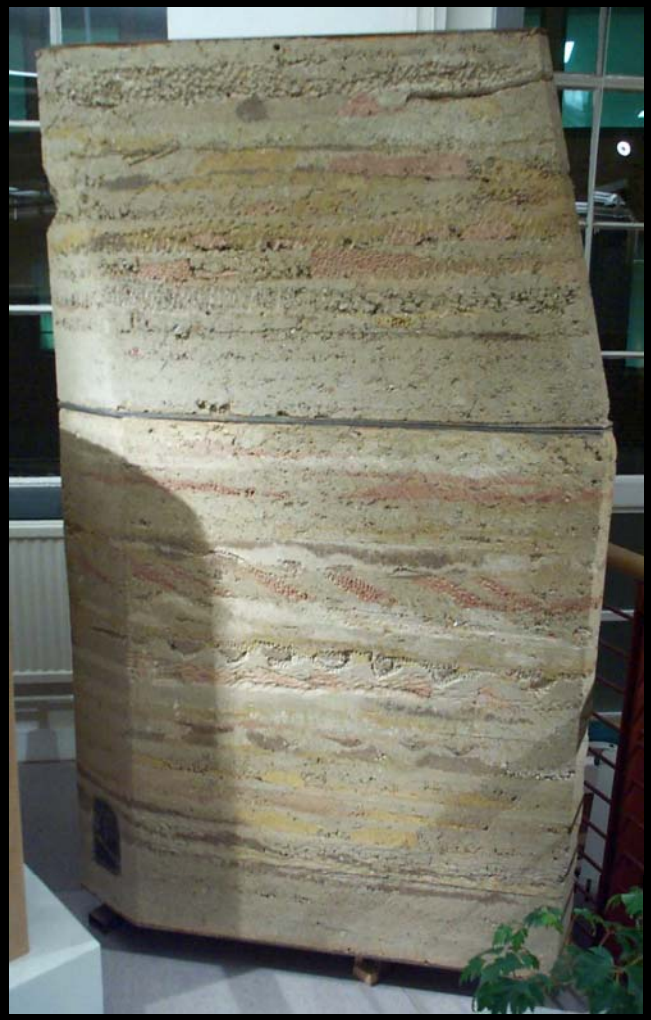


Rammed Earth Walls

- Abundant and Natural
- Recipe can be determined on site
- Thermal, Acoustic & Moisture mass
- Fire resistant
- Load-bearing
- Absorbs radiation, smells and moisture
- Hygroscopic
- any shape
- many ingredients, colours & textures
- Sculptural & Artistic opportunities
- Waste disposal back to earth
- Recyclable & Reusable
- Labour intensive craft based
- Needs temporary formwork



Rammed Earth Walls

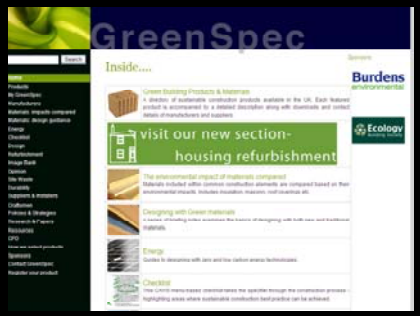


any shape
many ingredients
colours & textures

thermal mass

Load-bearing
but dynamic

Pines Calyx



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www.greenspec.co.uk

Earthships

CI/SfB (21) External Walls

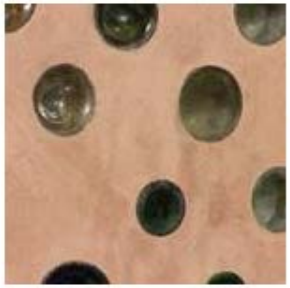
Earthships

- Old vehicle tyres retaining walls
- Rammed earth filling
- Rendered (lime render?)
- Uses Solar Gain and Thermal mass
- Brighton community centre now planning houses
- Scotland: Earthship Fife
- Market share: 2+ buildings = Zero
- www.lowcarbon.co.uk/earthsip-brighton/earthship-brighton-by-numbers

LOW CARBON TRUST

Earthship Brighton by numbers

- 1,000 used car tyres rammed in walls
- 700m - distance if all tyres where put in a line
- 125m2 total floor area
- 5 rooms - meeting space, office, kitchen, bathroom and conservatory
- £330,000 - total cost of development
- 48,000 litres - rainwater that can be harvested a year
- 1,500 card board boxes used
- 2 grey water planters, combined total area 12.5m2
- 5 skylights for natural ventilation
- 124 people trained in earthship construction in 2003
- 18 photo-voltaic panels providing the earthship with electricity
- 2 tonnes of can and bottles used
- 7 filters in rain purification system
- 40 batteries for electrical storage
- 2,800 litres - capacity of septic tank
- 4m - diameter of hut module
- 1 wind turbine - the first in Brighton and Hove
- 5,500 visitors in the last year

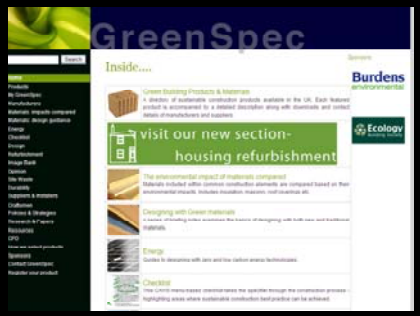


Earthship Brighton

- Earthship Brighton
- Earthships
- Sustainable Constuction
- Low impact materials
- Passive solar
- Renewable energy
- Rain harvesting 1
- Rain harvesting 2
- Plants treat waste
- Timeline start
- Timeline 2002/03
- Timeline 2004/05
- Timeline 2006/07
- Timeline now
- Earthship Brighton

Latest Updates

- Tour schedule
- Links
- Others:
- Passive solar - using the sun for space heating
- Site Map - where to find everything
- Services
- Sustainable Constuction - a holistic view
- Earthship Brighton - an overview
- Sponsors:
- Schools



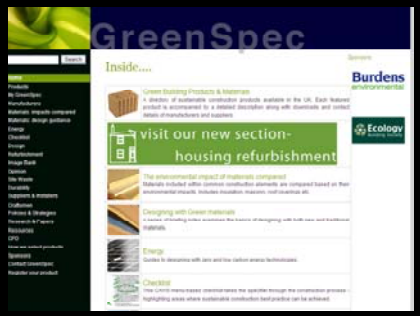
GreenSpec
www.greenspec.co.uk

Unfired clay brick and block Walls

CI/SfB (21) External Walls

Unfired Clay Brick & Block

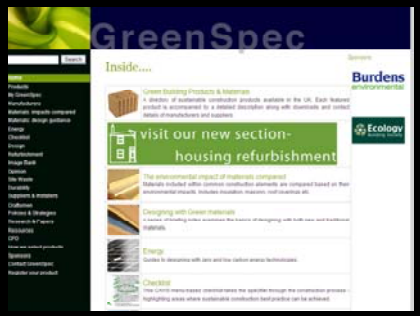
- W http://www.greenspec.co.uk/documents/whitepapers/EarthBrick.pdf#search='lime%20technology
- W http://www.greenspec.co.uk/html/materials/clay_bricks.html
- W http://www.limetechnology.co.uk/pages/sumatec.php



GreenSpec
www.greenspec.co.uk

Chalk Block Walls

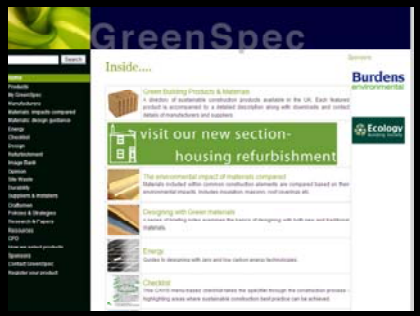
CI/SfB (21) External Walls



GreenSpec
www.greenspec.co.uk

Chalk blocks

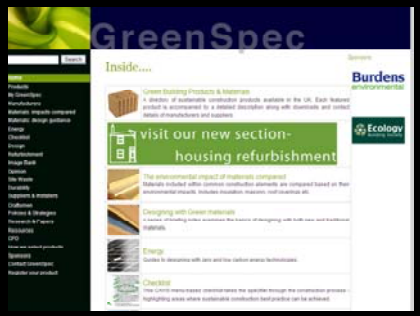
- W http://www.limetechnology.co.uk/home/index.php
- W http://www.limetechnology.co.uk/pages/sumatec.php
- but they seem to have withdrawn the product!



GreenSpec
www.greenspec.co.uk

Cob Walls

CI/SfB (21) External Walls



GreenSpec
www.greenspec.co.uk

- Guide
- http://www.greenspec.co.uk/html/design/handbuiltcob.html

Training Opportunities

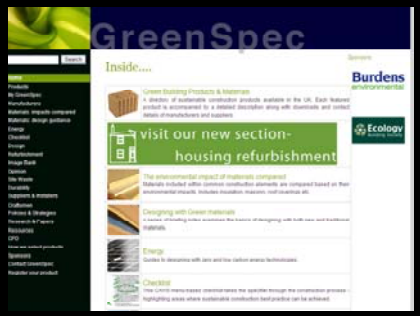
- Rounded Developments Enterprises.
- *September/October 2008

Cob building course and Lime rendering course.*

- Learn these simple natural building techniques
- Create a sheltered outdoor cob oven, leisure and bench seating area
- The Amelia Trust Farm, a local community space.

*Cob building course.

- Weekend course
- Learn about the theory and practicalities of cob building
- How to test for appropriate building sediment
- how to mix cob,
- various cob wall building techniques
- how to sculpt niches, shelves and decoration.
- After the course you will be able to go ahead and build your own cob ovens and benches.
- Maximum of 8 people per course



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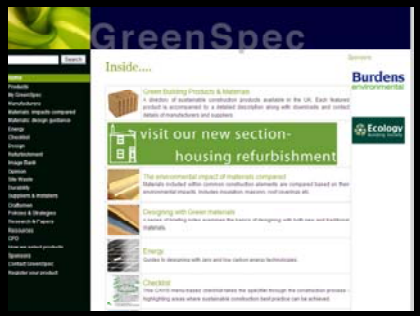
Contact:

- Anna Haslock Training and Education Officer
- T 02920403399
- E training@rounded-developments.org.uk
- Rounded Developments, 93 Portmanmoor Rd Ind Est. Splott, Cardiff, CF245HB
- W www.rounded-developments.org.uk
- Rounded Developments Enterprises is a not for profit organisation running the only sustainable building centre in Wales.



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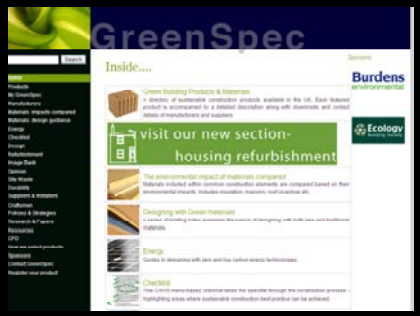
Limecrete Walls

CI/SfB (21) External Walls



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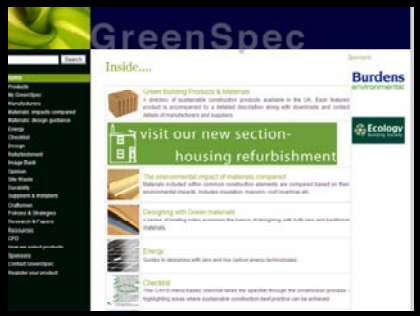
Limecrete

- W http://www.oldhousestore.co.uk/techohs/limecrete.html
- W http://www.greenspec.co.uk/html/products/list330.html



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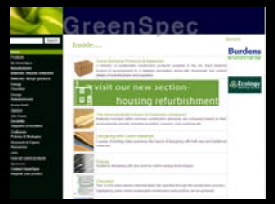
Timber Walls

Timber Constructions



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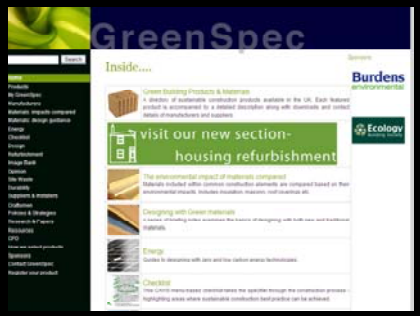
(21) Timber External Walls

CI/SfB (21.1) Load-bearing

(21.3) Non Load-bearing

Another GreenSpec CPD to download soon



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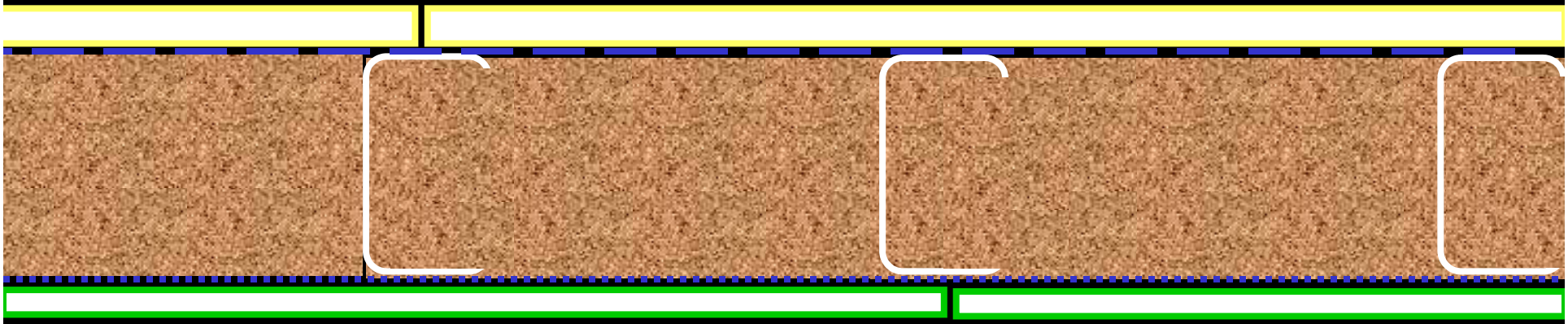
Metal frame panel external walls

Metal Stud External Walls



Metal C Studs, Thermal Insulation, Breather Membrane, inner lining, Vapour Barrier, outer lining

Even at 400 mm. thickness metal stud is still a significant cold bridge in this construction

Greenwich Millennium Village Phase 2a

- Egan initiative implemented: prefabrication off-site, simple assembly on site, reduction of site waste
- later on-site factory-production

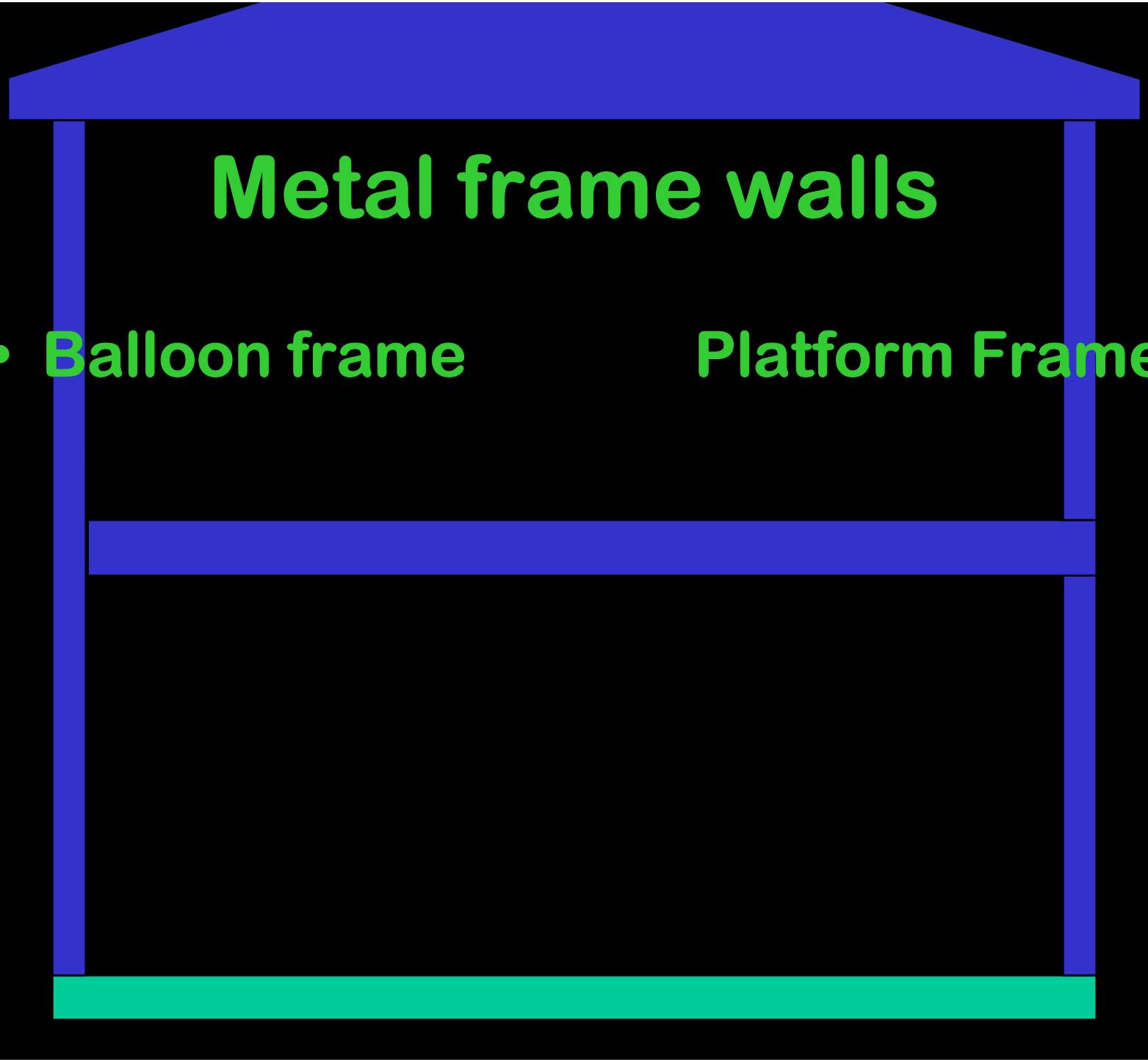
GMV Phase 2b 4 storey framed & panel infill

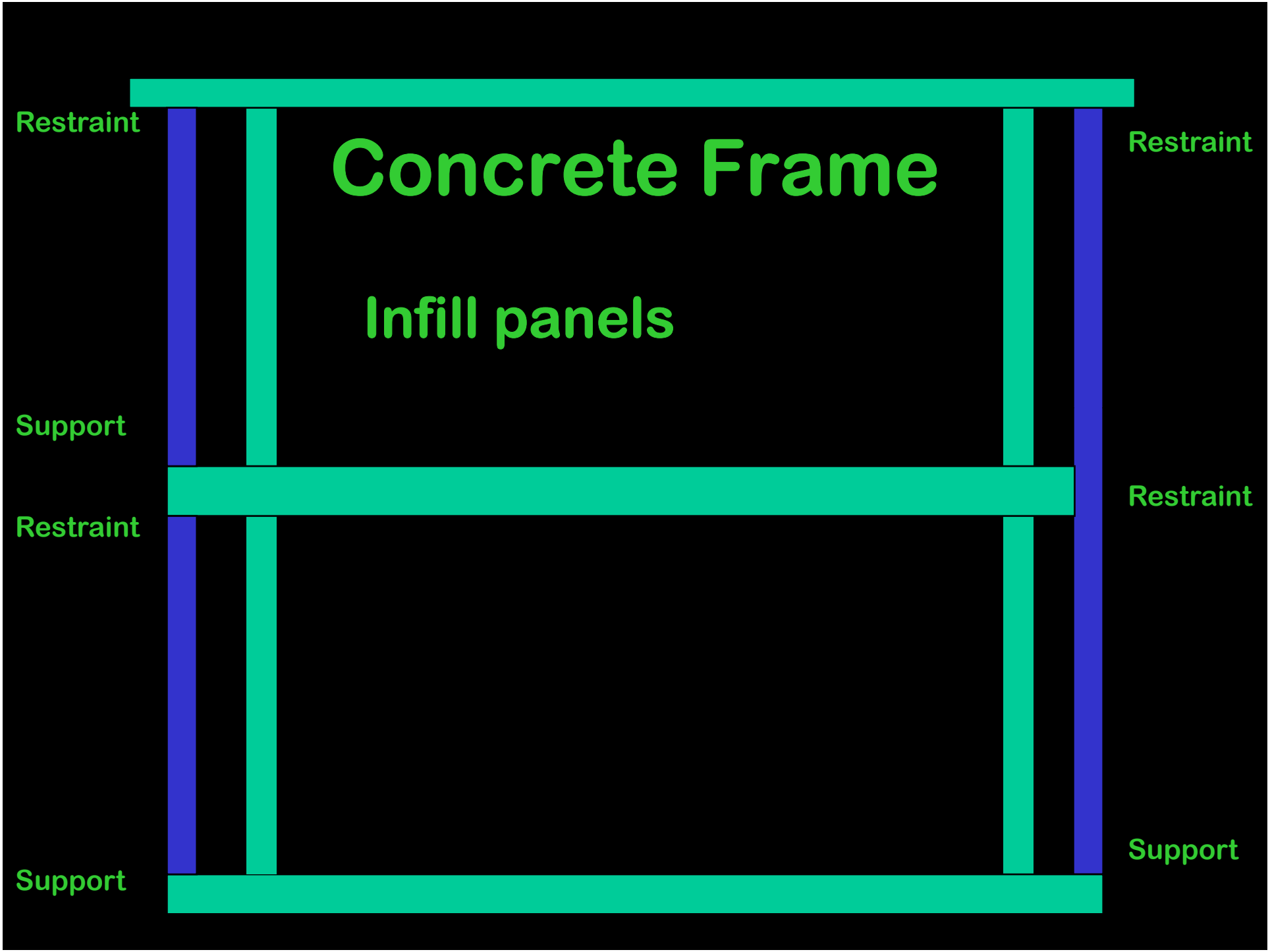
Greenwich Millennium Village © NGS

Metal frame walls

- Balloon frame

Platform Frame




Restraint
Concrete Frame
Restraint
Infill panels
Support
Restraint
Restraint
Support
Support

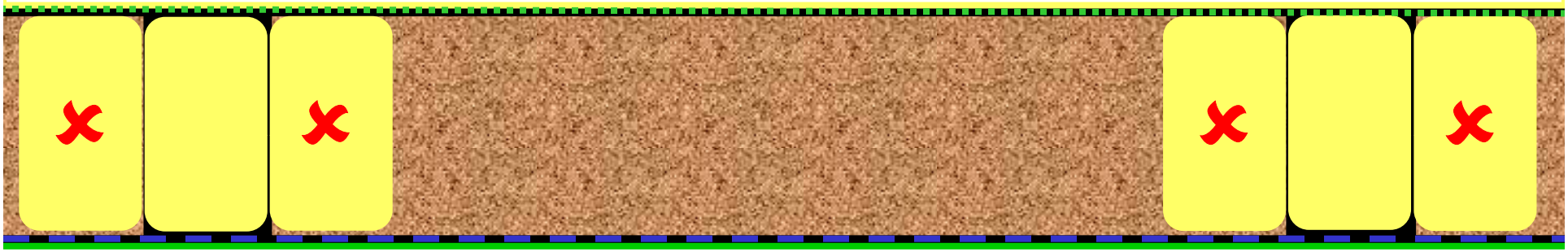
GMV Greenwich Millennium Village Phase 2b

4 storey concrete framed and metal framed panel infill © NGS

Factory Prefabrication:

- Conditions ensure no deterioration
- No mud or cement splashes
- No rain to spoil
- Use of all the materials supplied
- Reusing until all is gone
- Virtually no waste

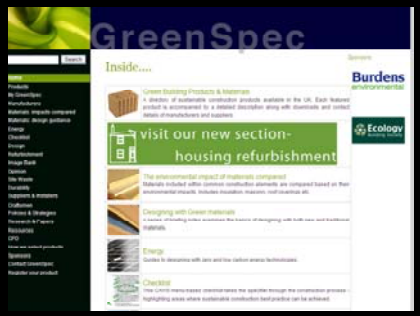
Strength v U Value in external wall



Avoid over design of structure around openings
Avoid lack of design: adding additional studs for luck
Avoid creating wide cold bridges through insulation
Avoid Waste: chopping thermal insulation rolls

400 mm. thick insulated wall: 60 x 400 mm. studs at 600 mm. centres

Passivhaus have determined Psi (cold bridge) factors are acceptable
metal studs remain a significant cold bridge



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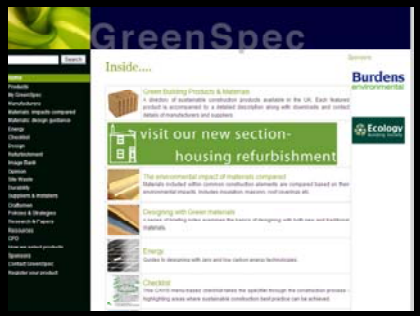
MMC Modern Methods of Construction



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Insulated Structural Floor, wall & roof Panels

Timber Constructions

GreenSpec
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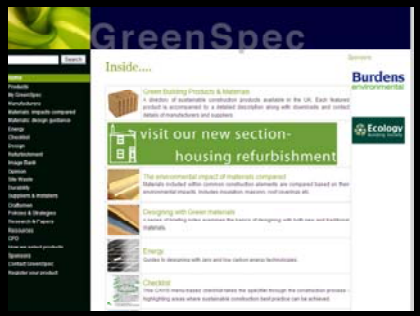
SIPS Structural Insulated Panel Systems

Another GreenSpec CPD to download soon



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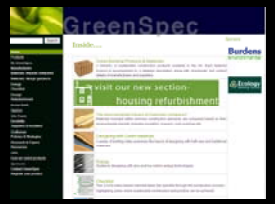
Masonry External Walls

CI/SfB (21) External Walls



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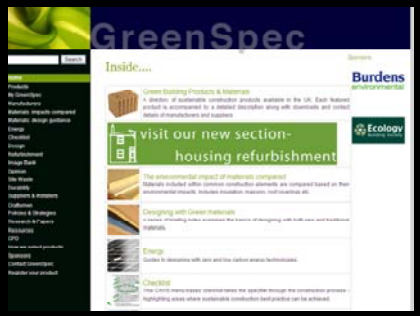
(21) Masonry External Walls

CI/SfB (21.1) Load-bearing

(21.3) Non Load-bearing

Another GreenSpec CPD to download soon



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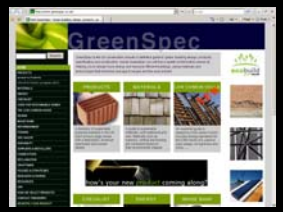
Insitu Concrete Walls

CI/SfB (21) External Walls



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Violet materials: Cement Concrete & Blockwork

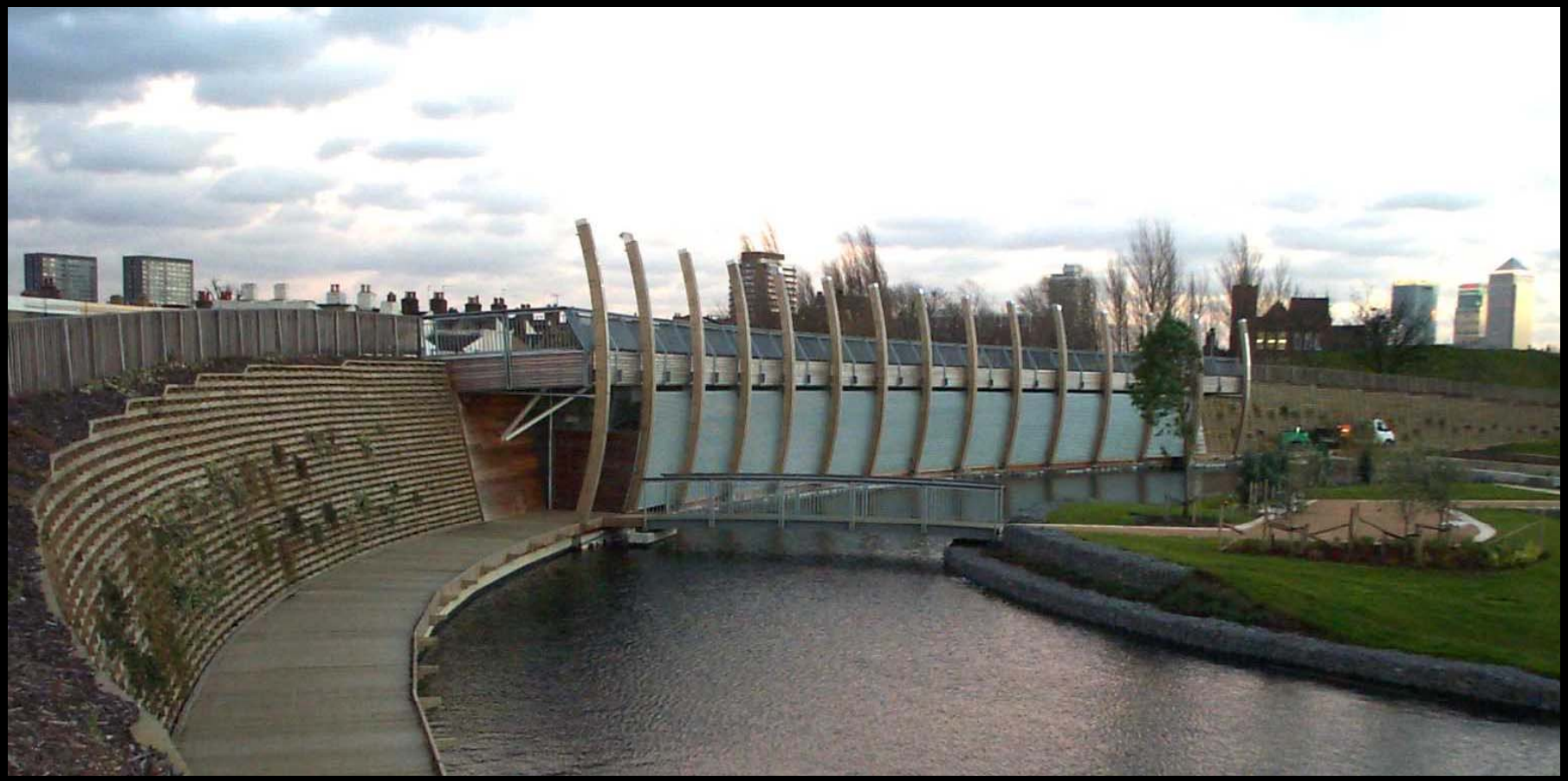
The Environment & The Problems
The Competition & Some Solutions

Another GreenSpec CPD to download soon

1960's insitu concrete tower refurbishment

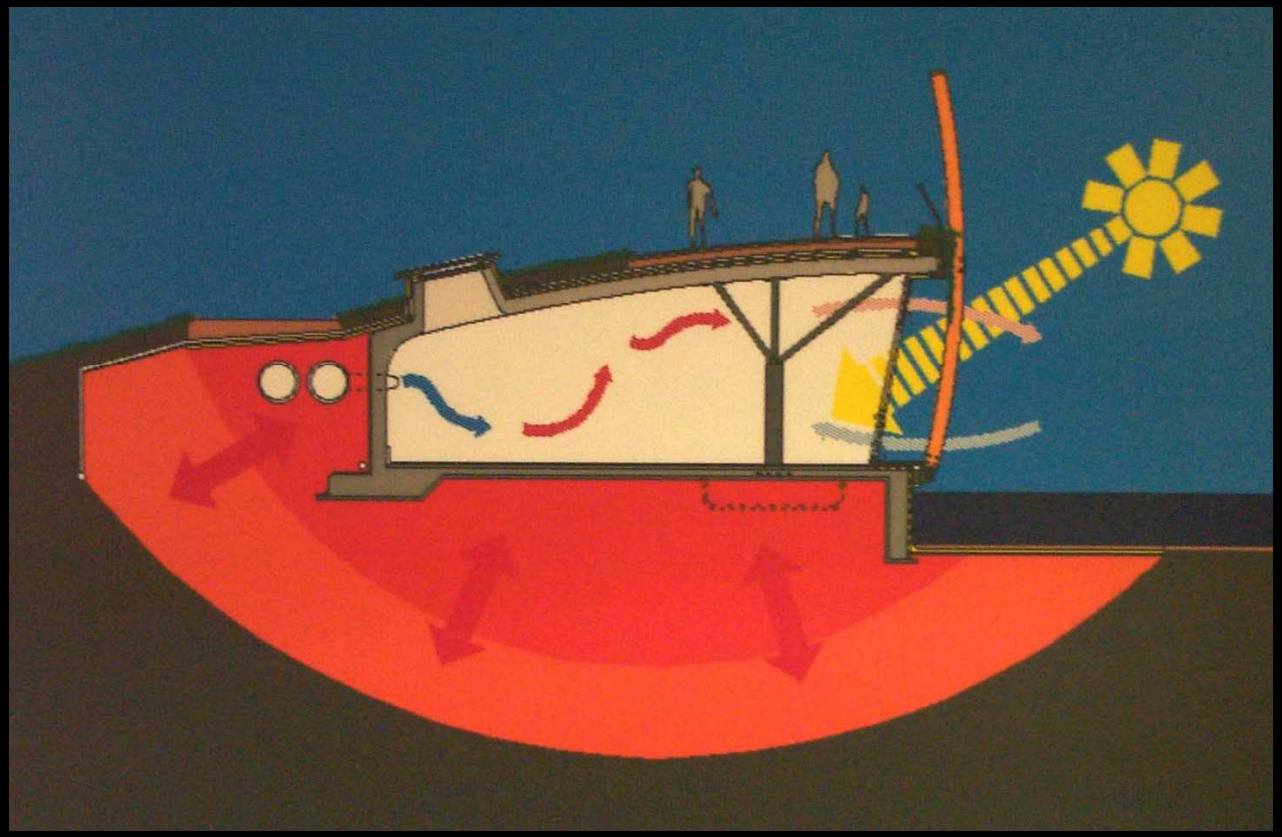
- Eco Energy Refurbishment

Zero Energy Development



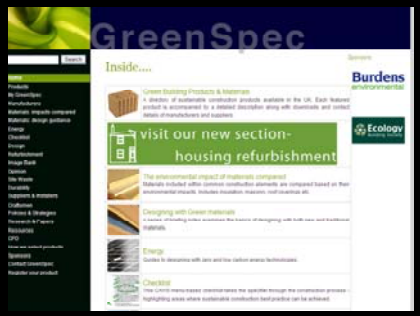
Mile End Road Park

Zero Energy Development



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

Mile End Road Park, E London



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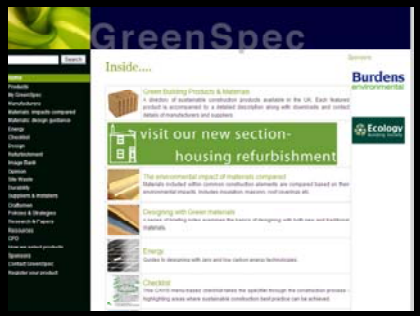
Wall Integrity at Floor Junctions

CI/SfB (21) External Walls

Weather, Acoustic, Fire, Thermal, Airtightness



Floor Joists in external walls

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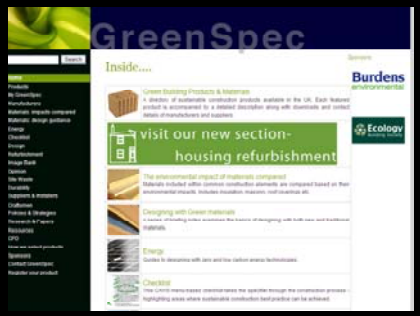
Joist penetrations into wall need to be airtight and not form air gaps for heat loss

Party Walls act as heat stacks

Attic spaces

Party walls between
flats and terraced or
semi-detached houses

Acoustic details in
Party walls make
heat loss prevention difficult



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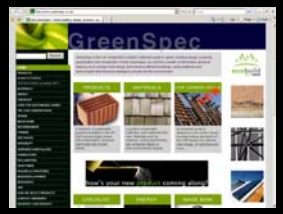
Resource Efficiency



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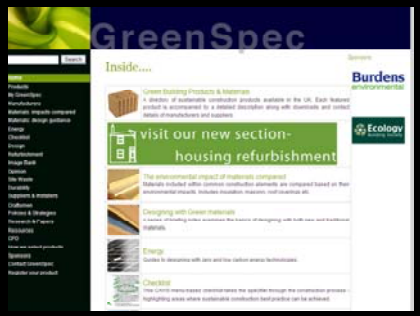
Design to help Reduce Waste

Easy steps to reduce your share
of the 90 m tonnes of construction and
demolition and excavation waste each year

Another GreenSpec CPD to download soon



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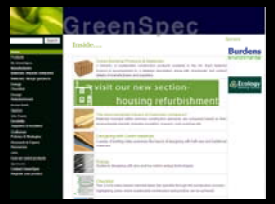
Glass External Walls



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Glass External Walls

(21.4) Curtain Walls

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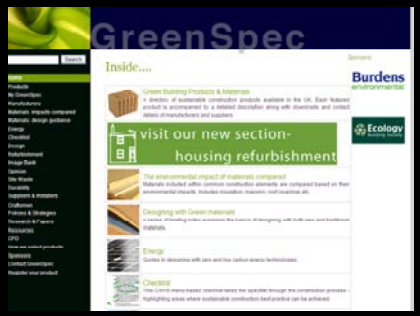

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- Specification Writer by Choice
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