

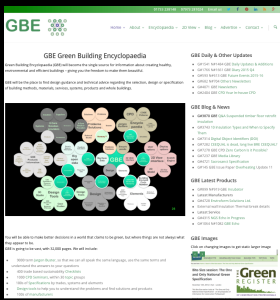


(27.2) Pitched Roofs

CI/SfB (27.2) Pitched Roofs

LSBU RIBA Part 1 Degree Architecture Tech & Env2 Lecture

- Domestic, Small & Medium size buildings
- Construction methods, materials, services and systems
- Pitched Roofs



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CAP'EM
Cycle Assessment Procedure for Eco-impacts of Materials



Performance Requirements

Principles of Element Design

THIRD EDITION

PRINCIPLES OF
element
design



Peter Rich &
Yvonne Dean



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 Dip (env) 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 BA (Hons) BA (Dist) BArch, 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.

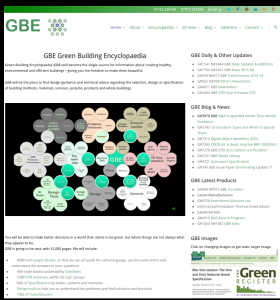


Architectural Press

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<http://www.bh.com>

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Principles

Pitched Roof Actions

- **Gravity:** downward pull
- **Wind:** Motive, Destructive, Penetrative, Scour, concentration of ballast and blow off roof
- **Rain:** Moisture deposition, penetration
- **Snow:** Moisture deposition, loading
- **Sun:** Temp variation, thermal movement, solar radiation heat gains, Chemical decomposition
- **Dirt and Dust:** infiltration, deposition, surface pollution
- **Chemicals:** corrosion, disintegration, decomposition
- **Sound:** Noise nuisance, from within and from without flanking from adjacent



Pitched Roof Reactions

- Gravity: Support & restraint
- Wind: rigidity, resilience, sealing, wind and air tightness, bonding/fastening/ballast, high upstands
- Rain: deflection, impervious skin, absorption and drainage, sealing
- Snow: retention, deflection, impervious skin, absorption and drainage, sealing
- Sun: reflection, albedo, thermal mass, decrement delay, movement joints, radiation, convection and conduction insulation, shielding, invulnerable materials
- Dirt and Dust: repulsion, exclusion, shielding, collection, cleaning, demineralisation
- Chemicals: invulnerable materials, exclusion, bio-remediation
- Sound: Insulation

Principles of Roof Design

- Roof form and types of weatherproof coverings
- Structural strength and stability
 - +ve and –ve pressure
- Weather shield
- Rain and other precipitation
- Snow: Weight, Insulation, reflection, Slippage, melt water run off
- Wind
 - Wind driven rain, wind driven snow, wind scour of ballast, wind driven melt water,
- Sun
 - UV radiation
 - Solar radiant Heat resistance
 - Internal conduction insulation
 - Overheating
- Dirt and dust
- Thermal performance
 - Thermal movement
 - Heat Gain and resistance
 - Heat loss and retention
 - Condensation risk
- Drainage:
 - Rain, snow melt water
 - Pitch and materials
 - Retention and Mitigation, SUDS
- Durability
- Sound Insulation
- Maintenance
 - External and internal, loading, safety
- Security
 - Entry through tiles and battens USA
- Fire,
 - External Fire Penetration
 - Internal Fire Spread
- Roof Access: Maintenance, cleaning, inspection, Safety
- Ventilation
- Rooflights
 - Privacy from overlooking
- Insect exclusion or selective inclusion
- Bat and Bird exclusion or inclusion

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 Thermal Bridges
 - Thermal Mass
 - Decrement Delay
- **Movement**
 - Structural , thermal, moisture, Frost
 - Creep
 - Chemical

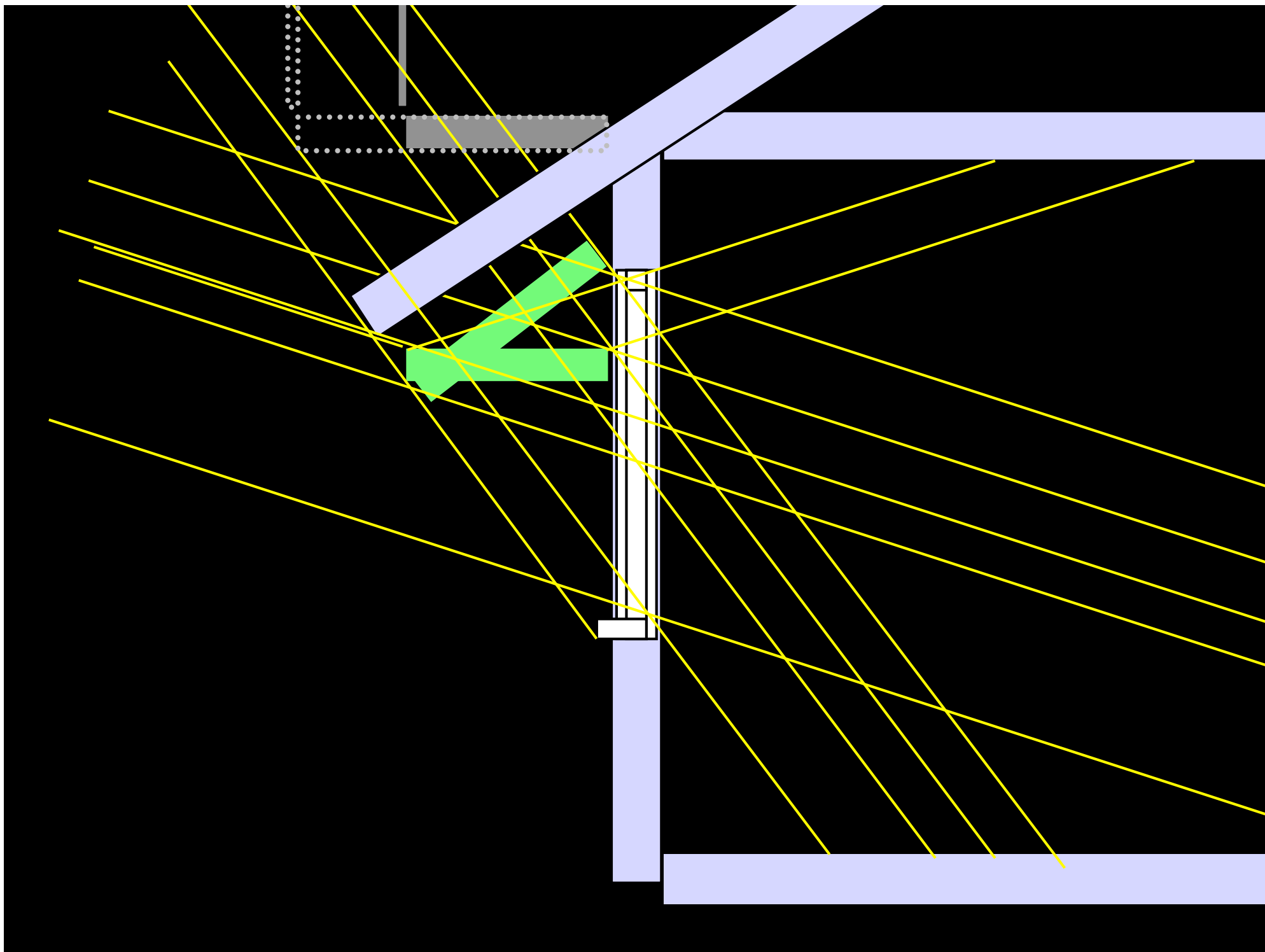
Principles of Element Design

- Acoustic Performance
 -
- Fire Performance
 -
 -
 -
- Security
- Inspection and maintenance
 -
- Biodiversity
 -
- Health
 -

**Eaves overhand
providing:
solar shading
& rain protection
Shelter**



Aberystwyth Arts Centre: Architect: Smith Roberts: Peter N Roberts





LCGB: Low Carbon Green Buildings

Brian Murphy (GreenSpec)

Another GBS CPD/Lecture file to download
and www.greenbuildingencyclopaedia.uk



www.greenspec.co.uk

Conduction Convection Radiation Conduction

Another GBS CPD/Lecture file to download
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Weather Envelope



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



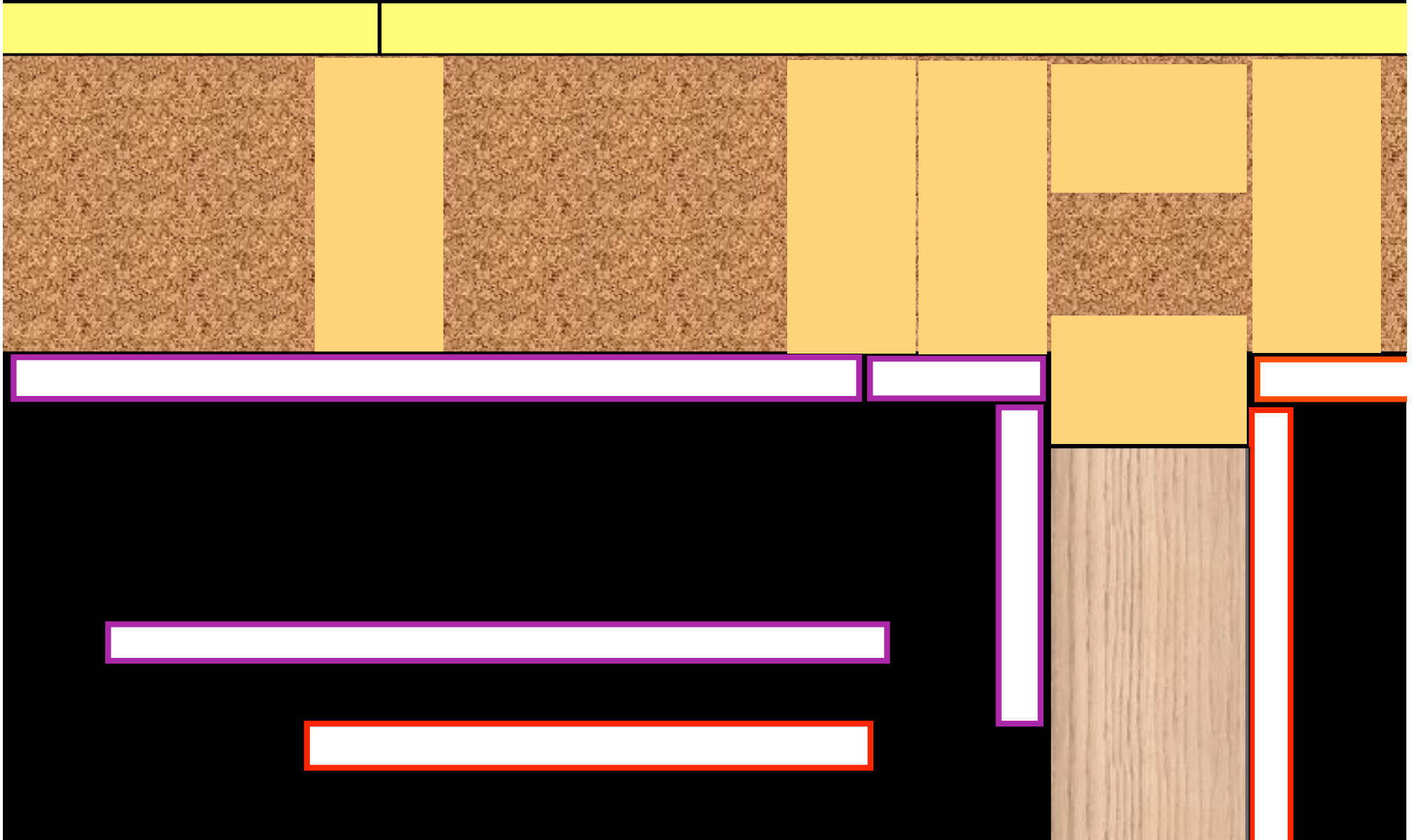
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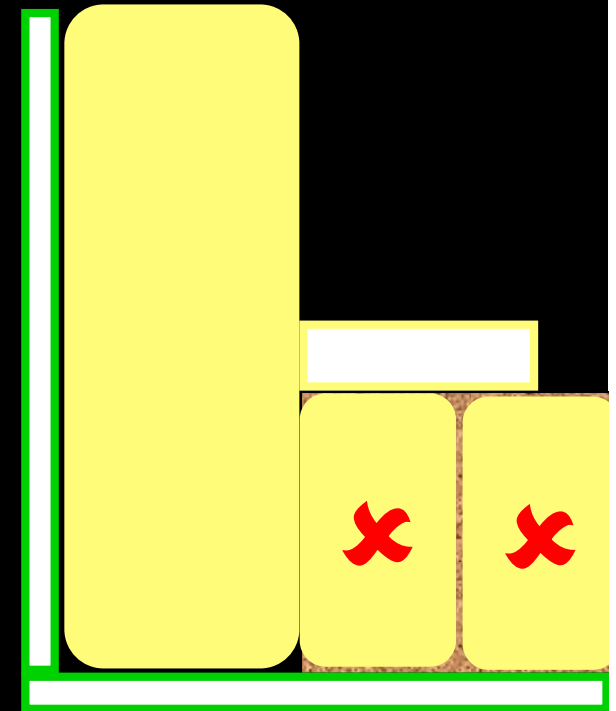
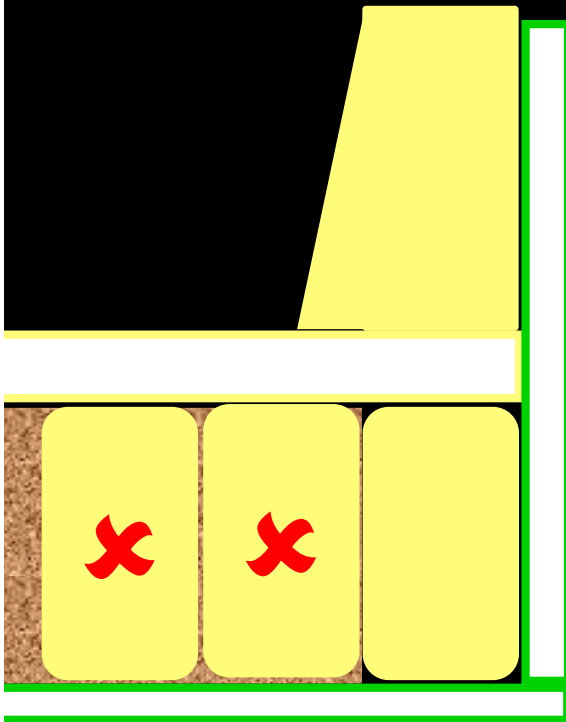


Insulation & Thermal Bridges

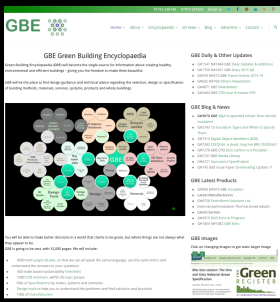
Timber ceiling joists interrupt the thermal insulation



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



Pitched timber roofs

CI/SfB (27) Pitched Timber Roof

Victorian Construction



- Eco Energy Refurbishment

Pre 1990s Construction



- Eco Energy Refurbishment

Pitched Roof

-
-
-
-
-
-
-
-



ulation
ne



Roof:
Compound rafters
Cellulose insulation
Upper Floor:
Acoustic bricks in floor
Laminated Timber floor planks
Lower floor:
Acoustic brick
Compound joist
Cellulose insulation
External wall:
Timber frame walls
Timber fibre insulation
Timber batten clad

Construction Resources Showrooms Southwark London

Pitched Roof

- e roof
- counter-battens
- Sheathing board
- joist
- fibre insulation
- lining



Pitched Roof

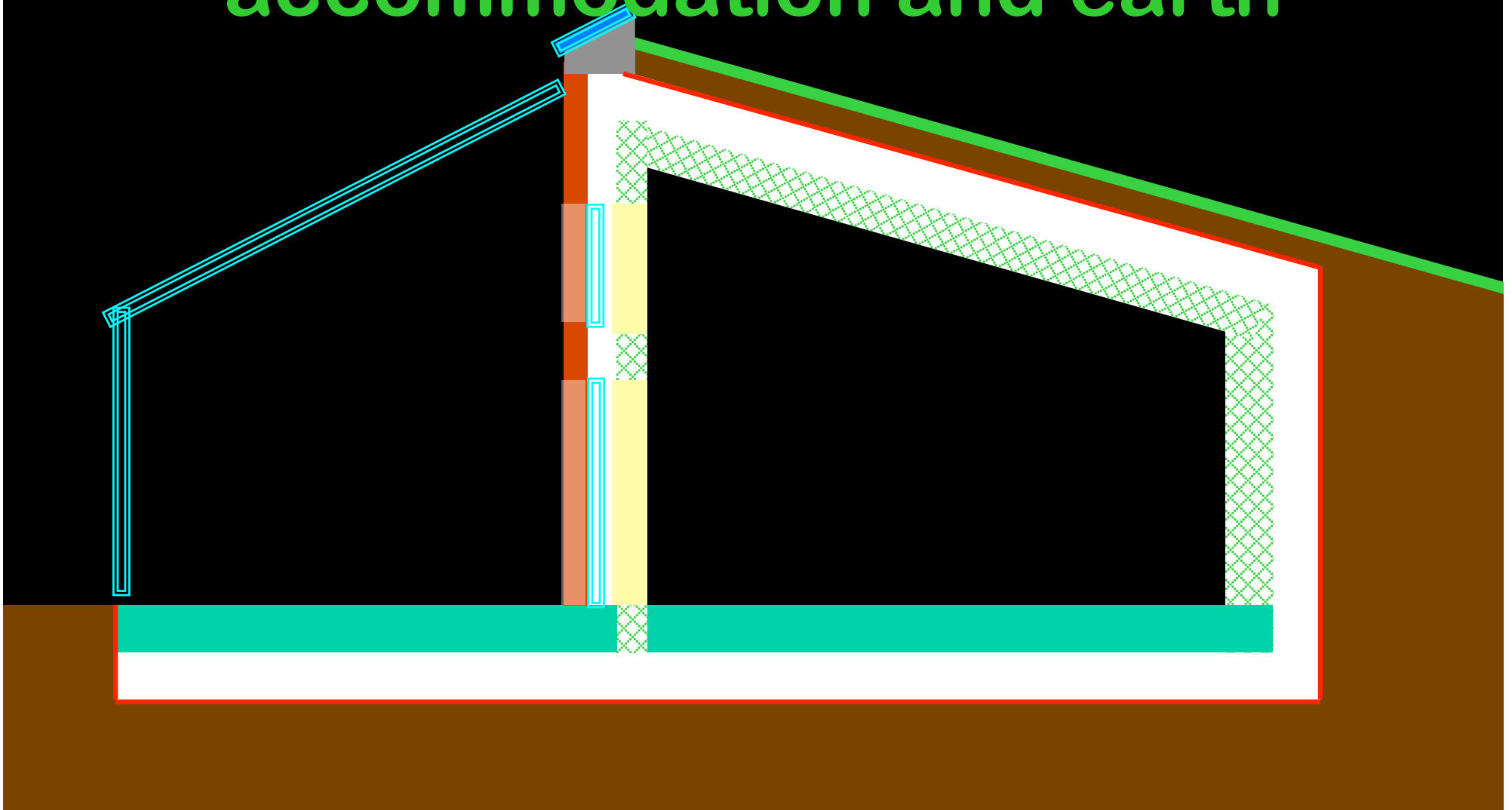


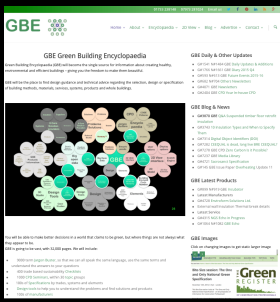
Clay roof tile
Battens & Counter-
battens
Sheathing Board
Deep timber joists
2 one above the other
Cellulose fibre
thermal insulation
Clay board lining
Clay skim
Paint

Precast concrete Beam & Block roof

CI/SfB (27) Roof

Solid concrete blockwork retaining wall Insulated outside between accommodation and earth





Insitu Concrete Roofs

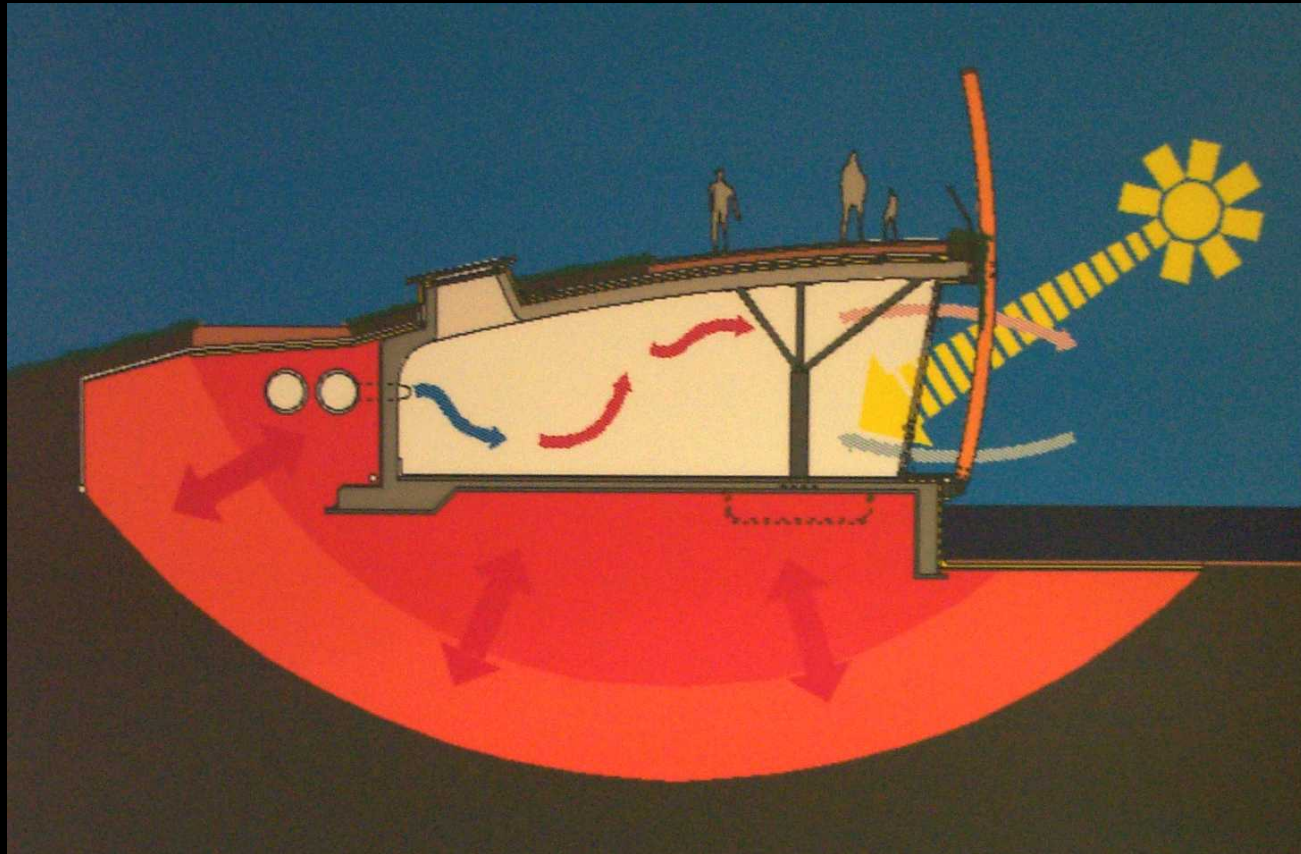
CI/SfB (27) External Roof

Zero Energy Development



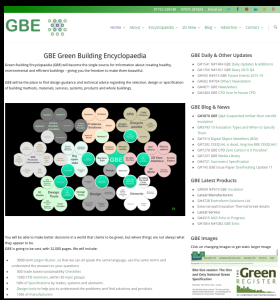
Mile End Road Park

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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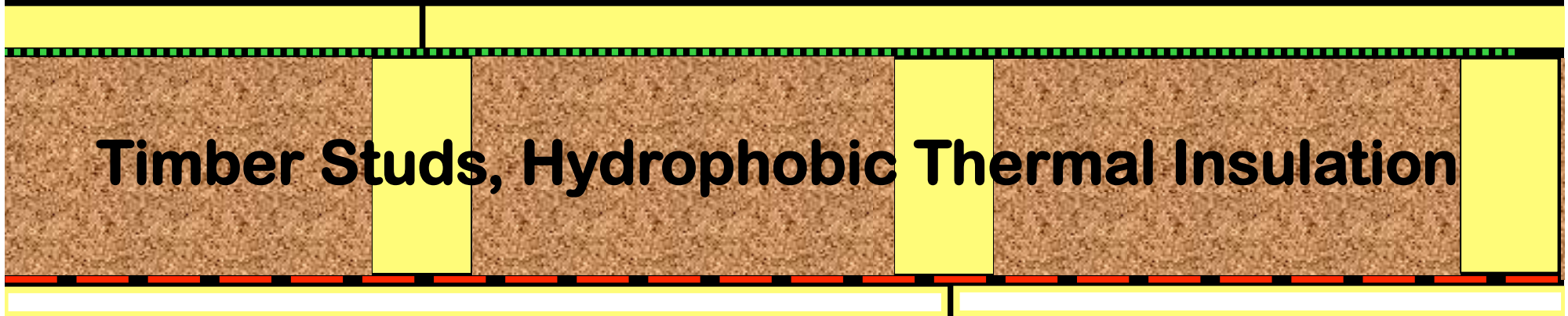
Timber Roofs

CI/SfB (27) External Roof

Timber Rafter Roof

Section
Outside

Breather Membrane, outer lining (plywood)

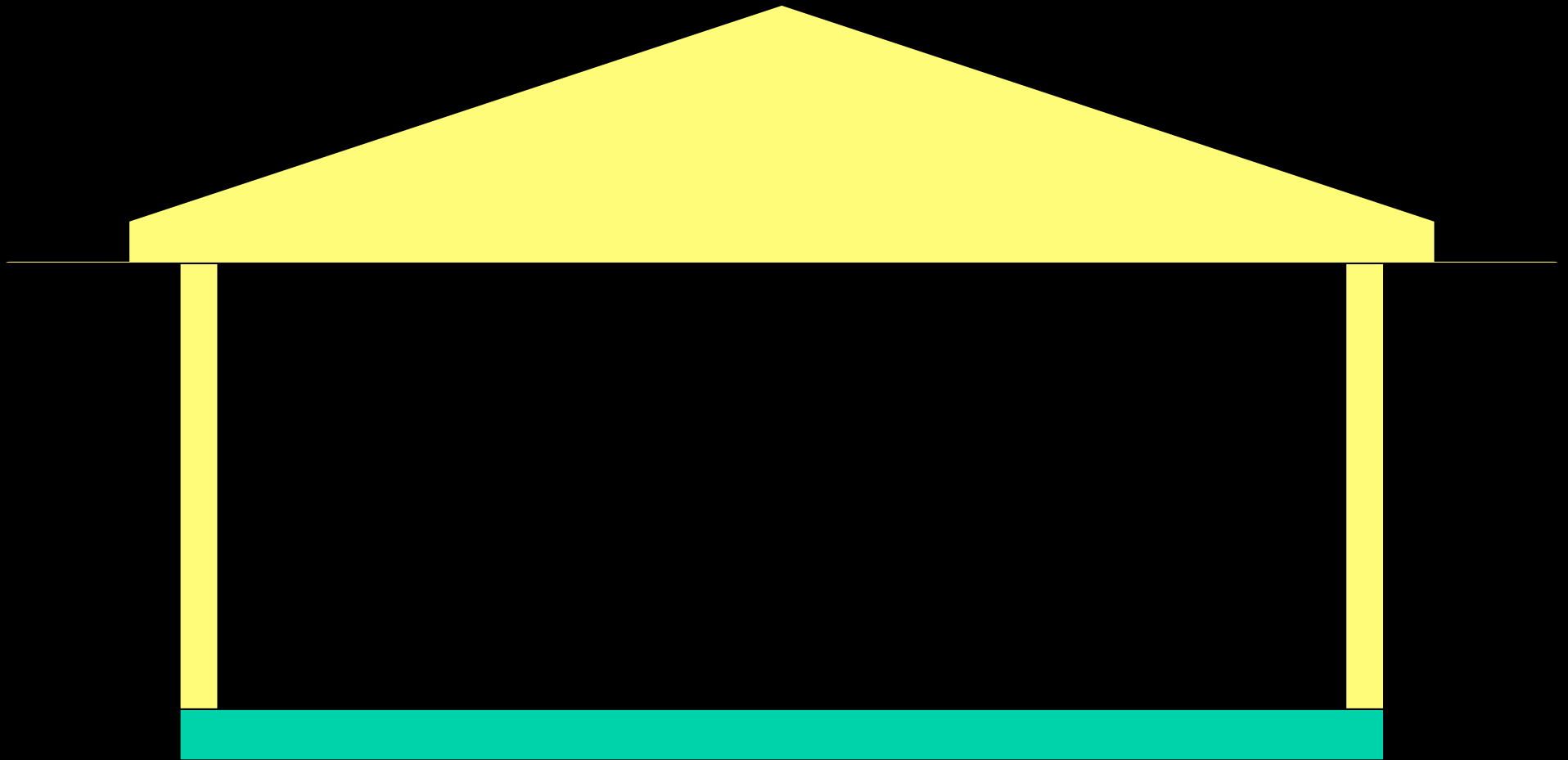


Timber Studs, Hydrophobic Thermal Insulation

Vapour Barrier, inner lining (plasterboard)
Inside

Timber sections: limited depth before
uneconomic or unobtainable

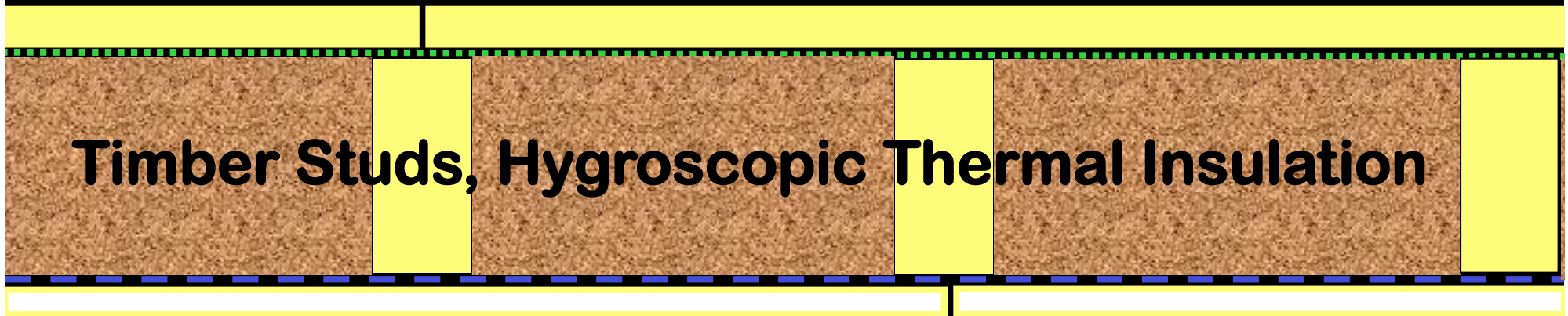
Timber framed roof



Breathing Roof

Section
Outside

Breather Membrane, Breathing Sheathing Board



Vapour permeable Air tightness layer, inner lining
Inside

Timber sections: limited depth before uneconomic
or unobtainable

Concrete Slab roof



Breathing Construction

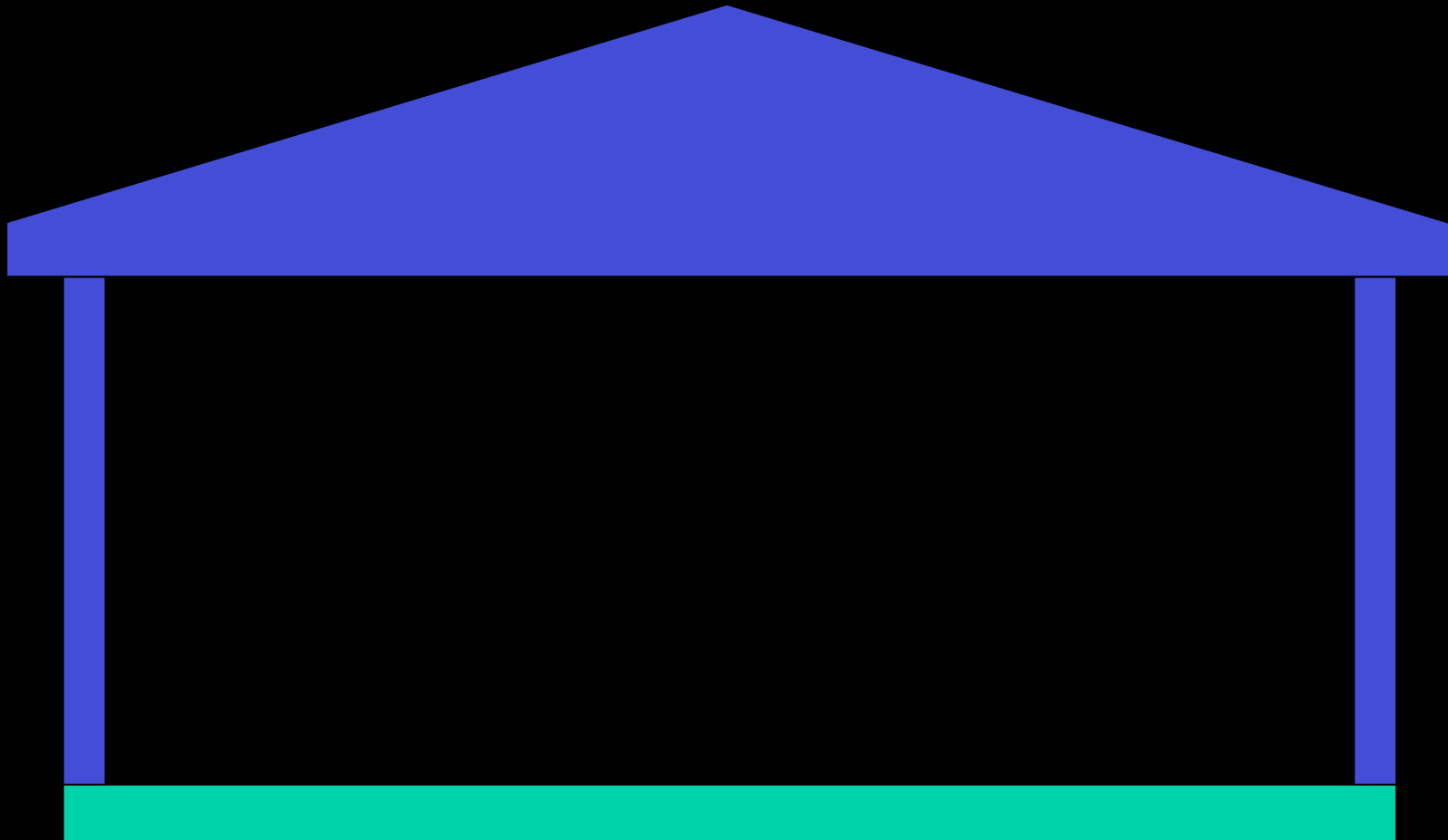
Another GreenSpec CPD to download soon

Metal rafter roofs



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

Metal frame walls



Factory Prefabrication:

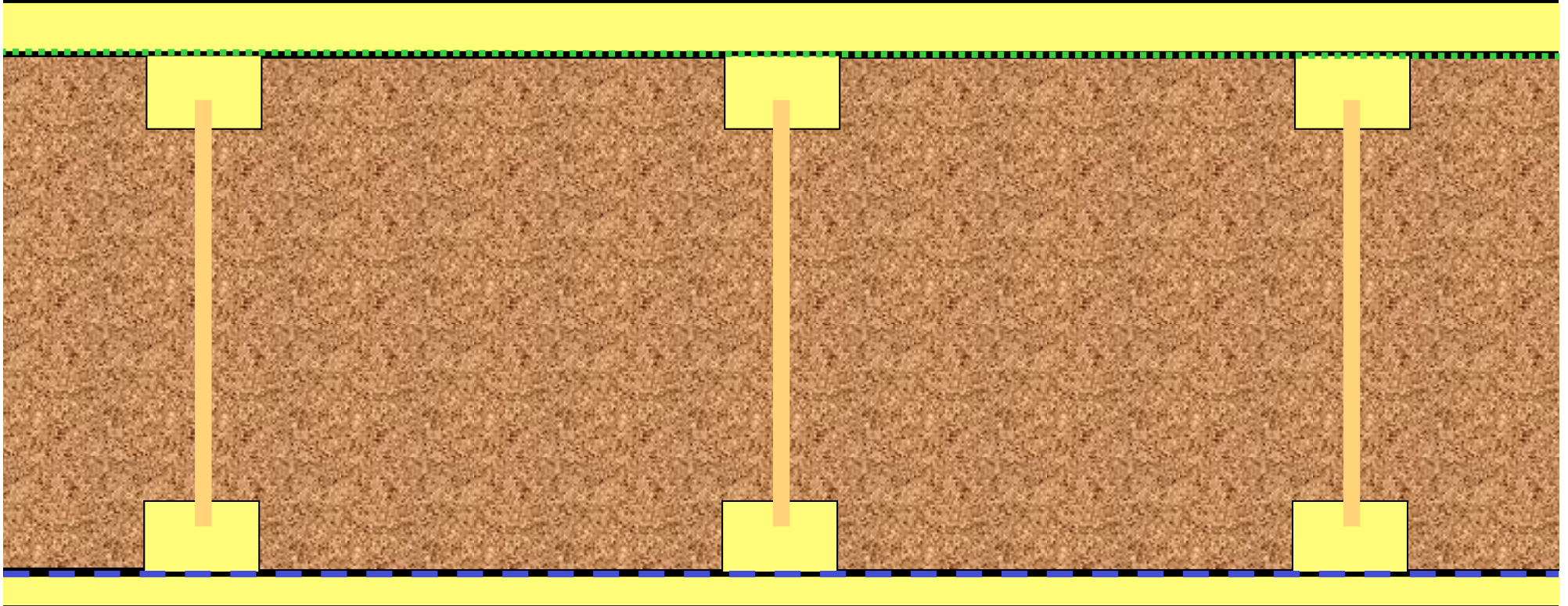
- Conditions ensure no deterioration
- No mud or cement splashes
- No rain to spoil
- Use of all the materials supplied
- Reusing until all is gone
- Virtually no waste

Strength v U Value in roof construction



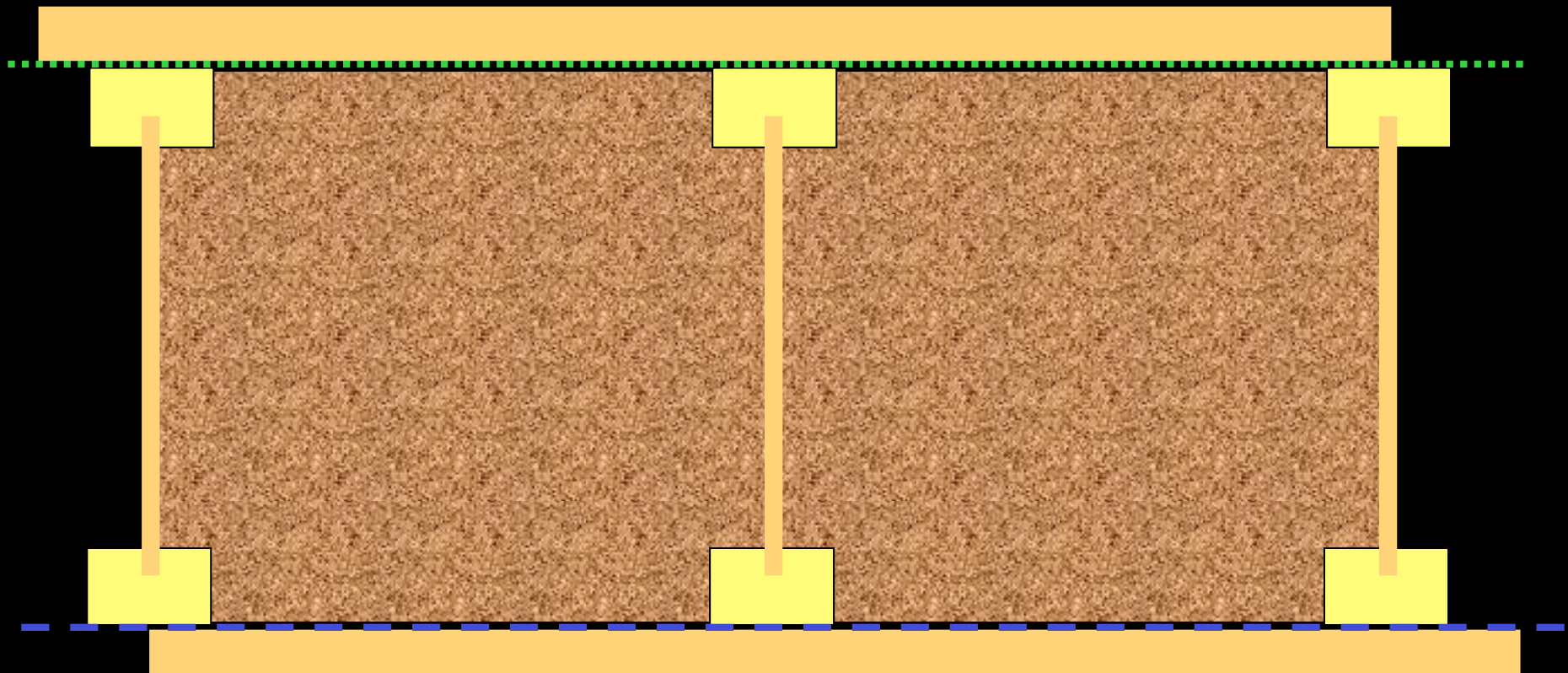
Avoid over design of structure around openings
Avoid lack of design: adding additional studs for luck
Avoid creating wide cold bridges through insulation
Avoid Waste: chopping thermal insulation rolls

Compound Section I Rafters to accommodate more thermal insulation



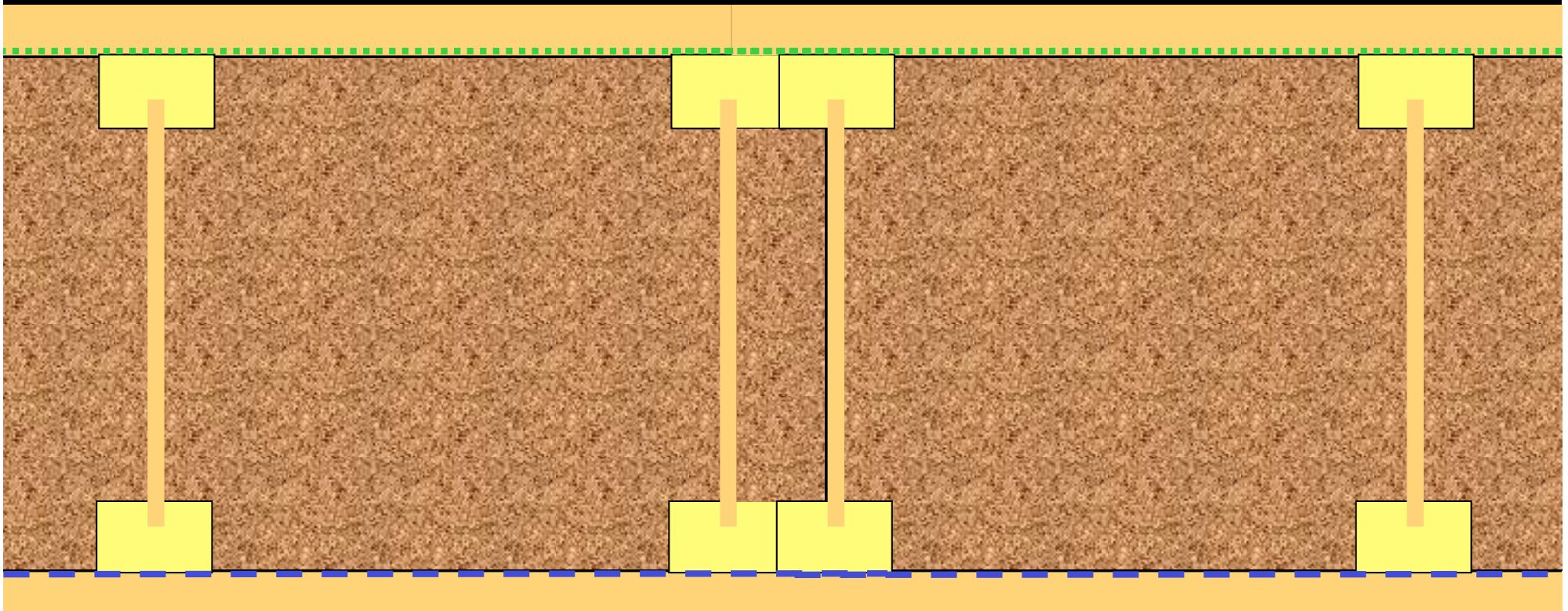
Compound section reduces amount of materials used, weight, cold-bridging

Compound Section I R rafters , inner and outer boards and thermal insulation



Prefabricated pitched roof panel

Compound section | Rafters, inner and outer boards and thermal insulation



Prefabricated pitched roof panels



Insulate structural Panels

Roof panels create
Habitable Roof Space

Platform Frame



Airtightness & Building Elements

12 of 25 Air Movement in Buildings

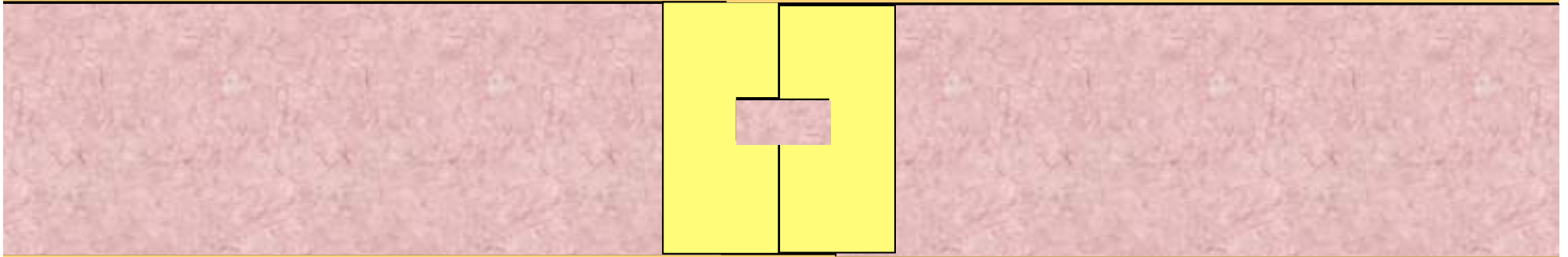
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and www.greenbuildingencyclopaedia.uk

SIP Structural Insulated Panel



Prefabricated pitched roof panel

SIP Structural Insulated Panel



Prefabricated pitched roof panel

Cross laminated Load-bearing Structural Timber Panel

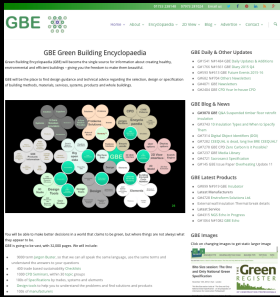


**Prefabricated pitched roof panel
softwood lamina or plywood core option**



Roof & Wall Junctions

CI/SfB: (21) External Walls
(27) Roofs



Roof Joists/Rafters in external walls

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Joist penetrations into wall
need to be airtight

**Biodiversity:
Pitched Roof:
Bat & Bird Roots**

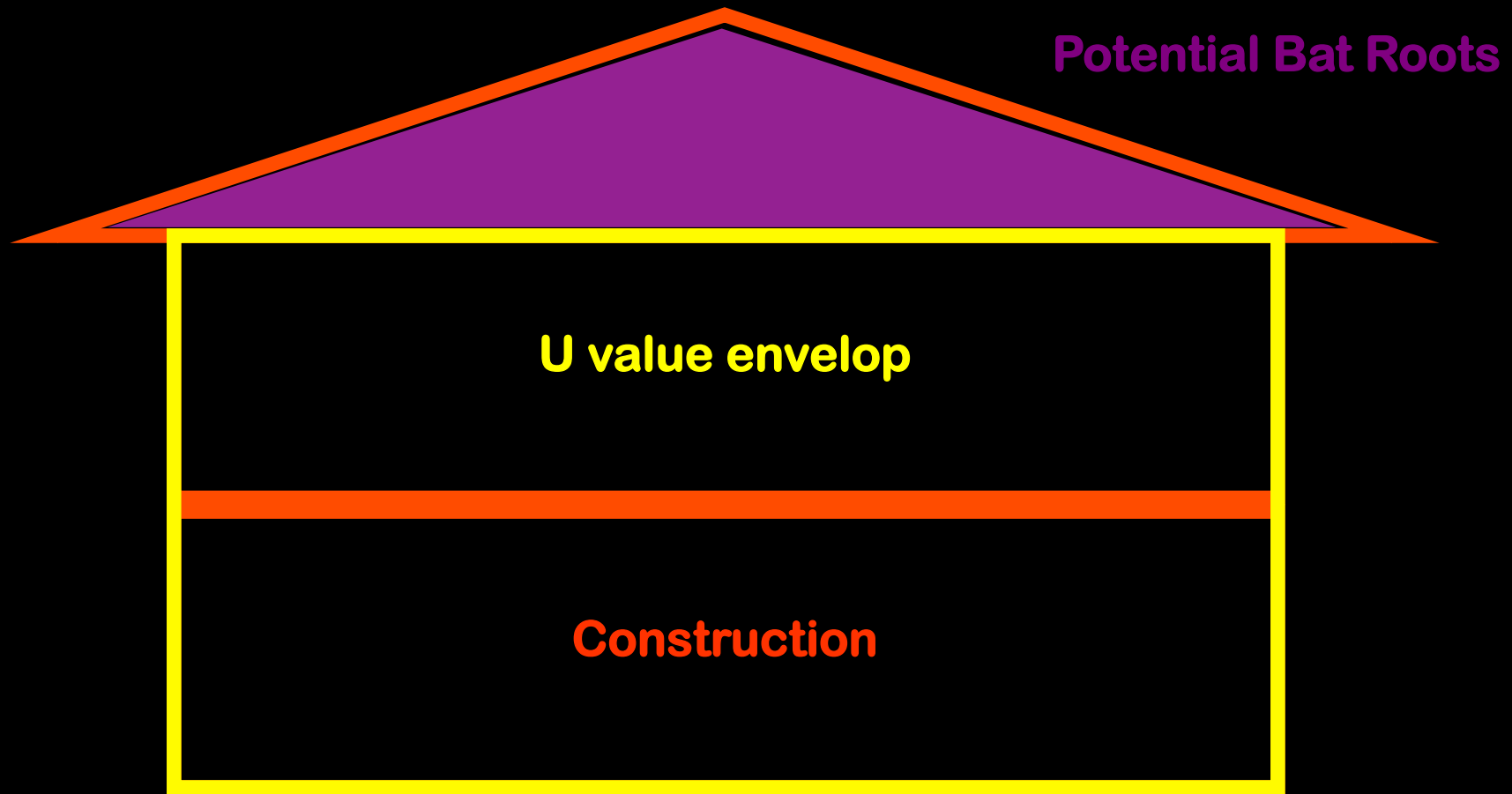
Dwellings

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

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

Attic in Roof



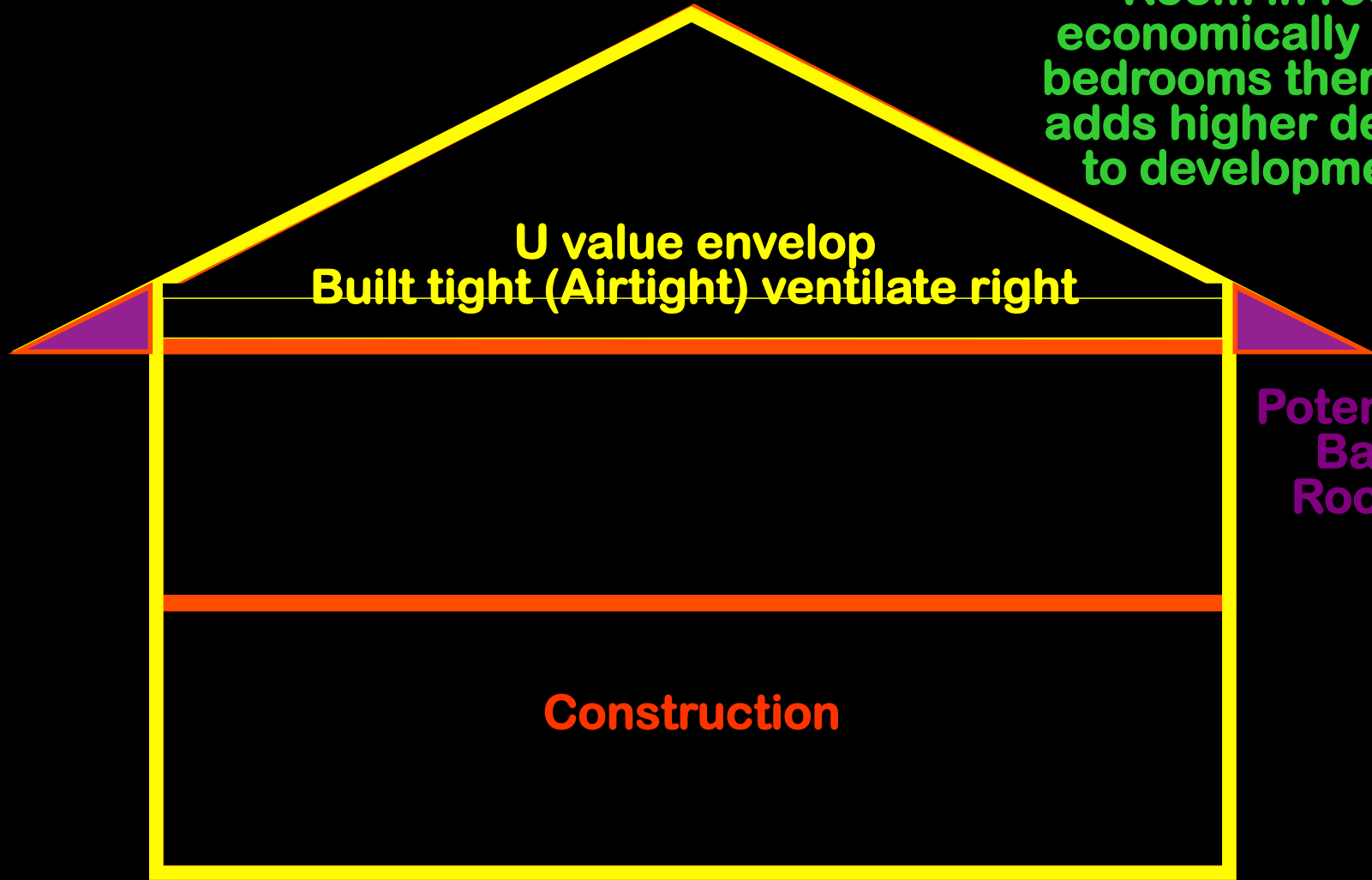
Room in Roof

Room in roof
economically adds
bedrooms therefore
adds higher density
to developments

U value envelop
Built tight (Airtight) ventilate right

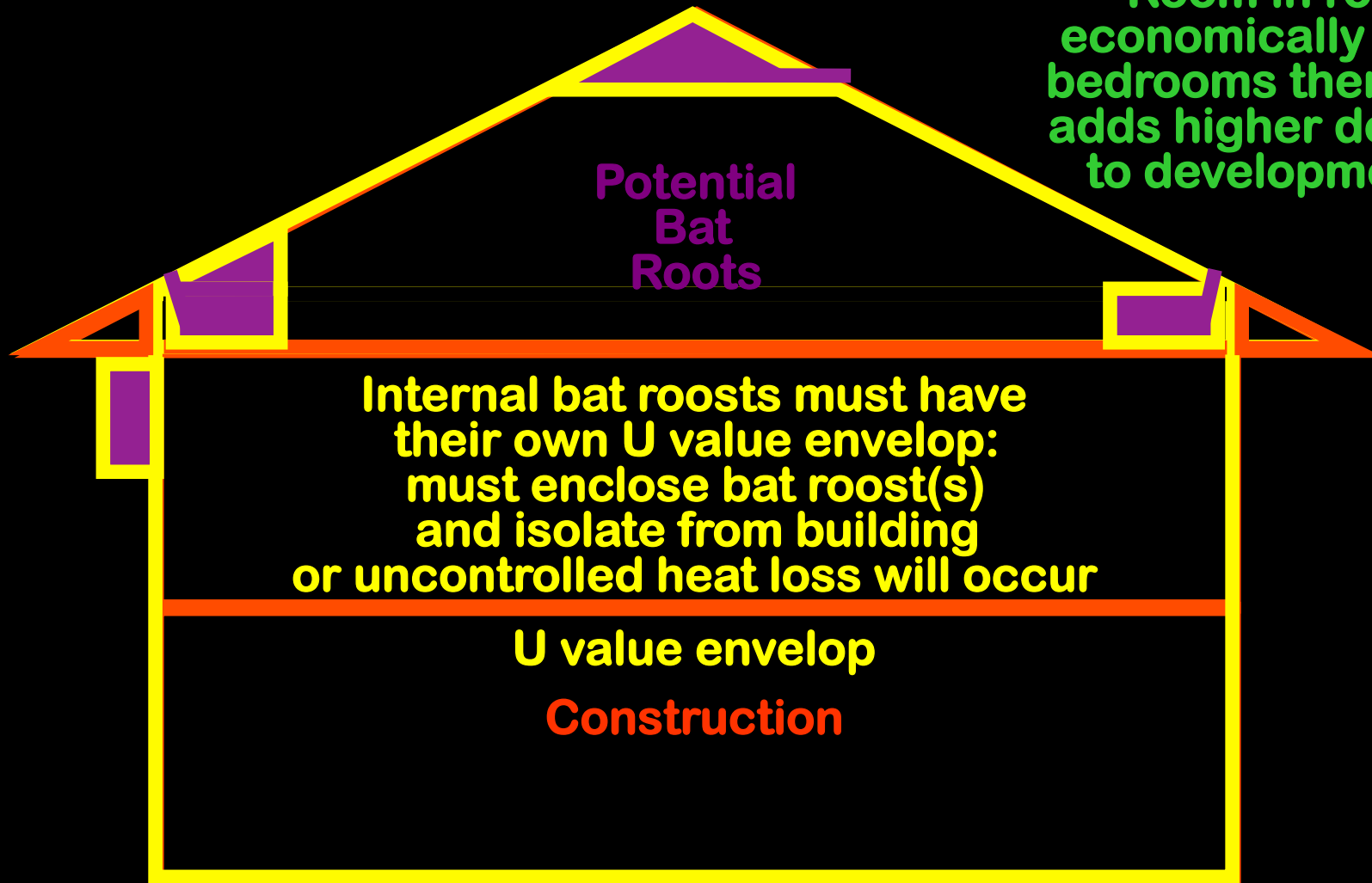
Potential
Bat
Roots

Construction



Room in Roof

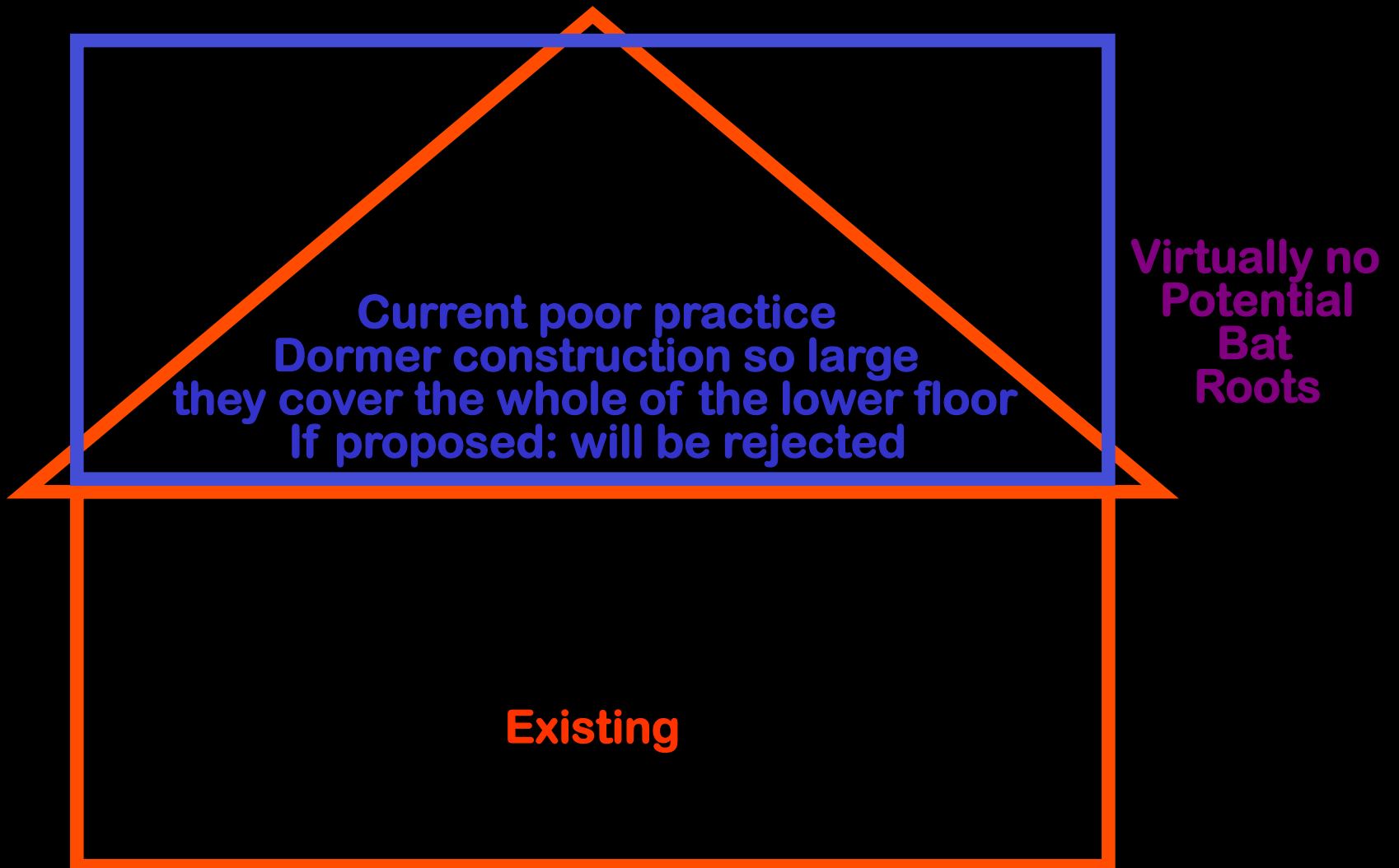
Room in roof economically adds bedrooms therefore adds higher density to developments



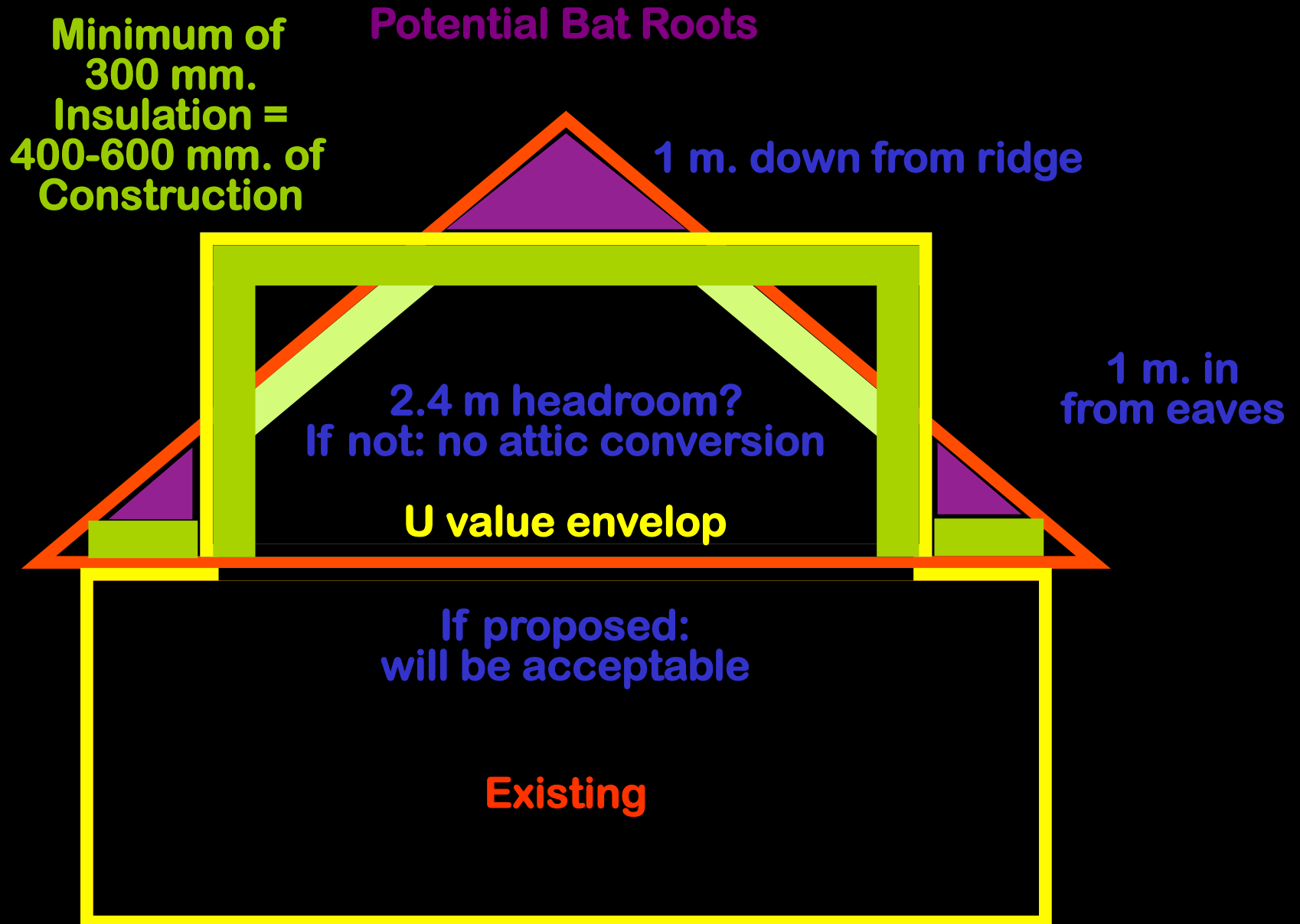
T&CP Permitted Development Consultation 2007

- 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

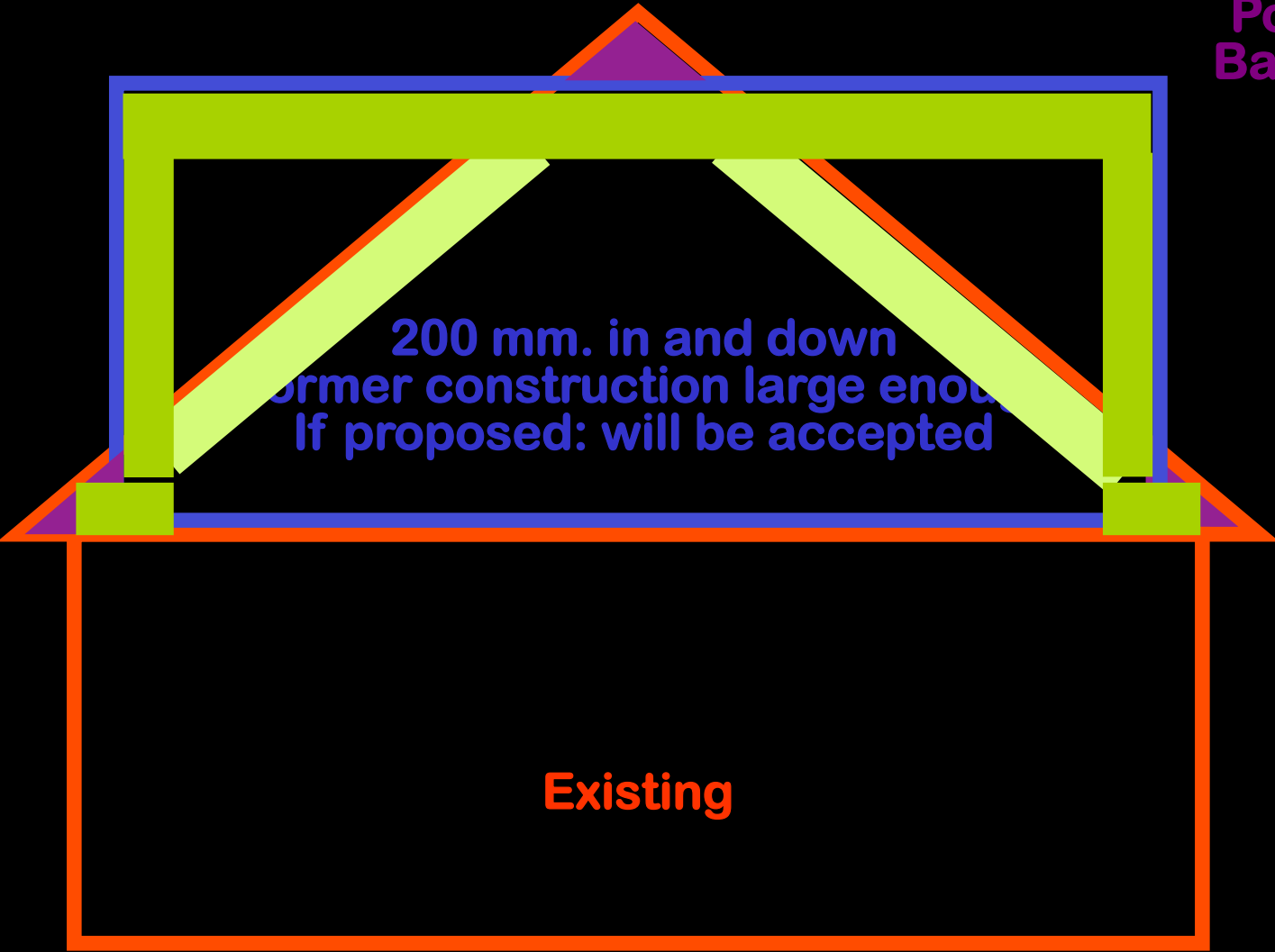


Rejected:

- **Planning Consultation overwhelming message:**
- **proposals rejected**
- **Significant numbers of roofs cannot fit 2.4 m headroom + 1 m in and/or down and insulated construction**
- **200 mm. in and down is new proposal**

Attic Conversions: proposed

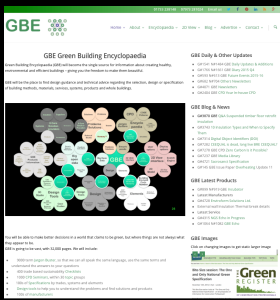
Very small
Potential
Bat & Bird
Root



200 mm. in and down
former construction large enough.
If proposed: will be accepted

Existing





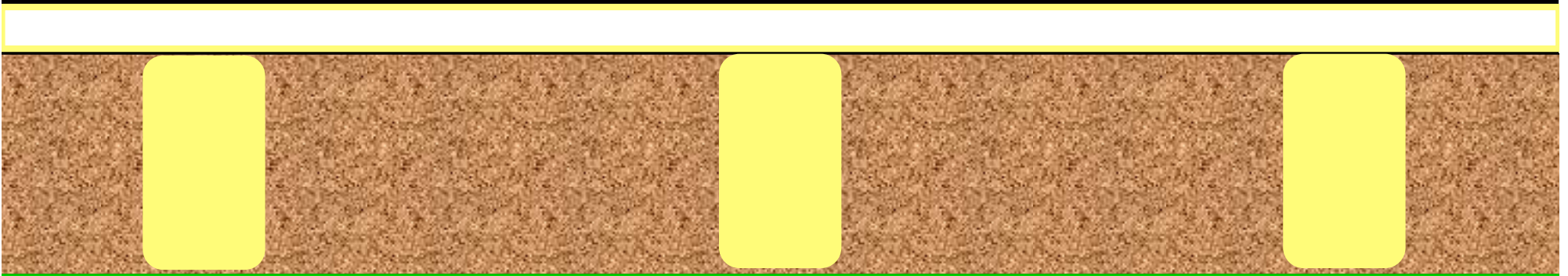
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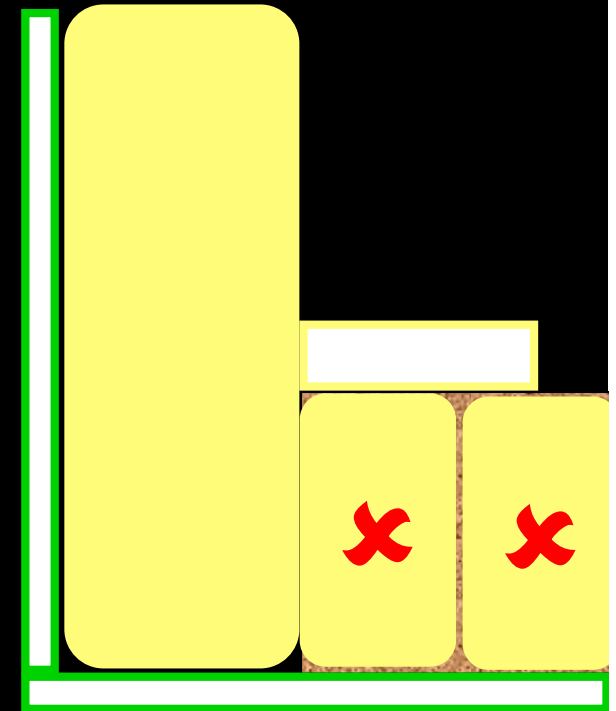
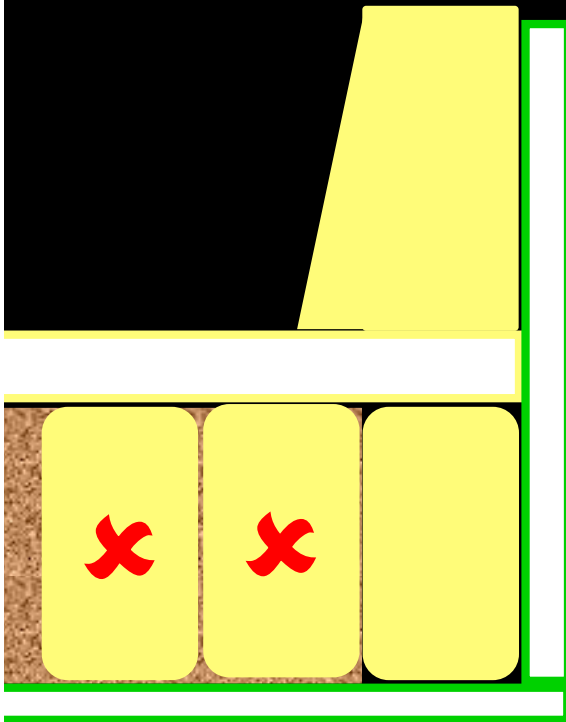
Resource Efficiency

Roof Rafters

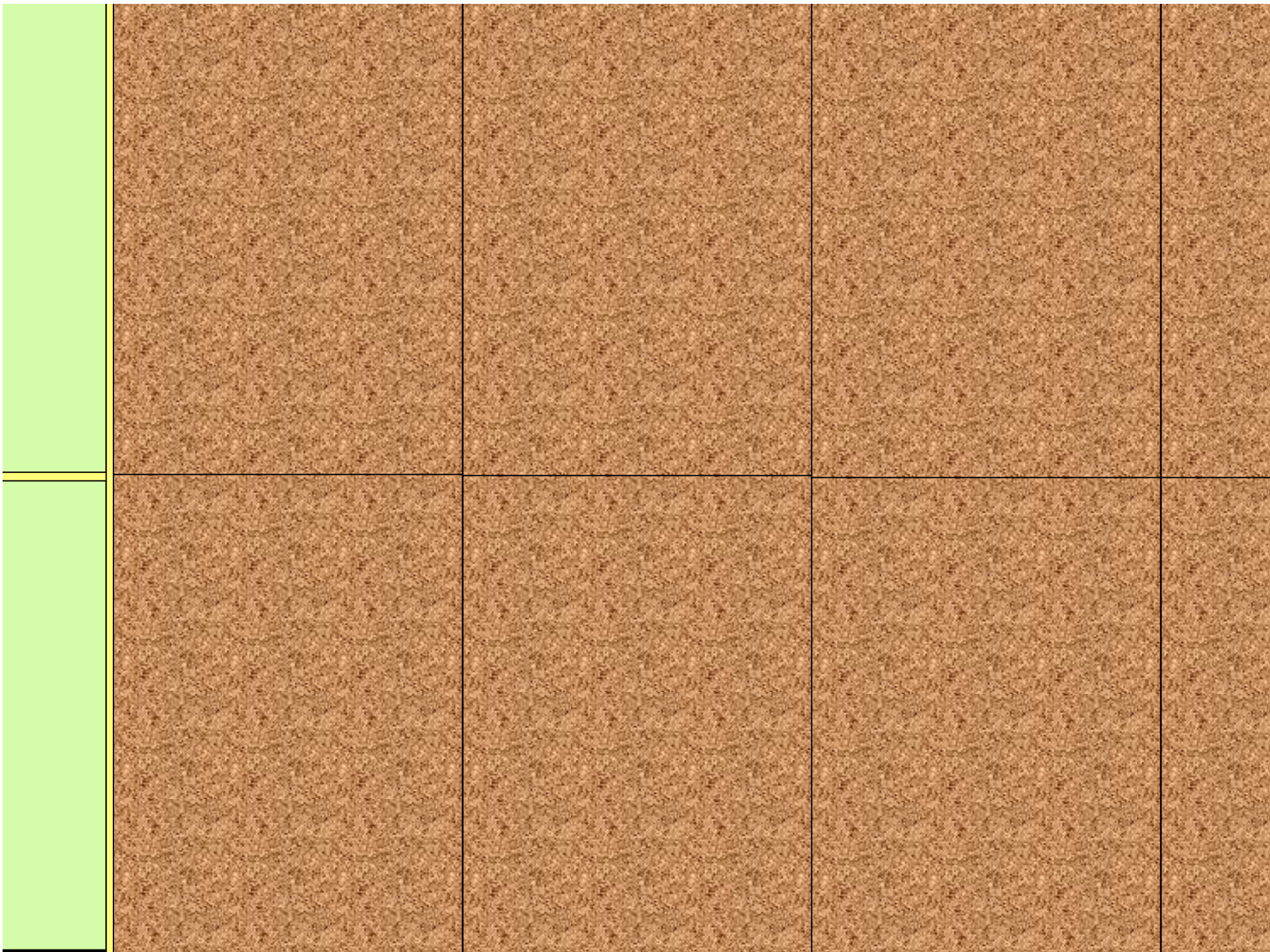


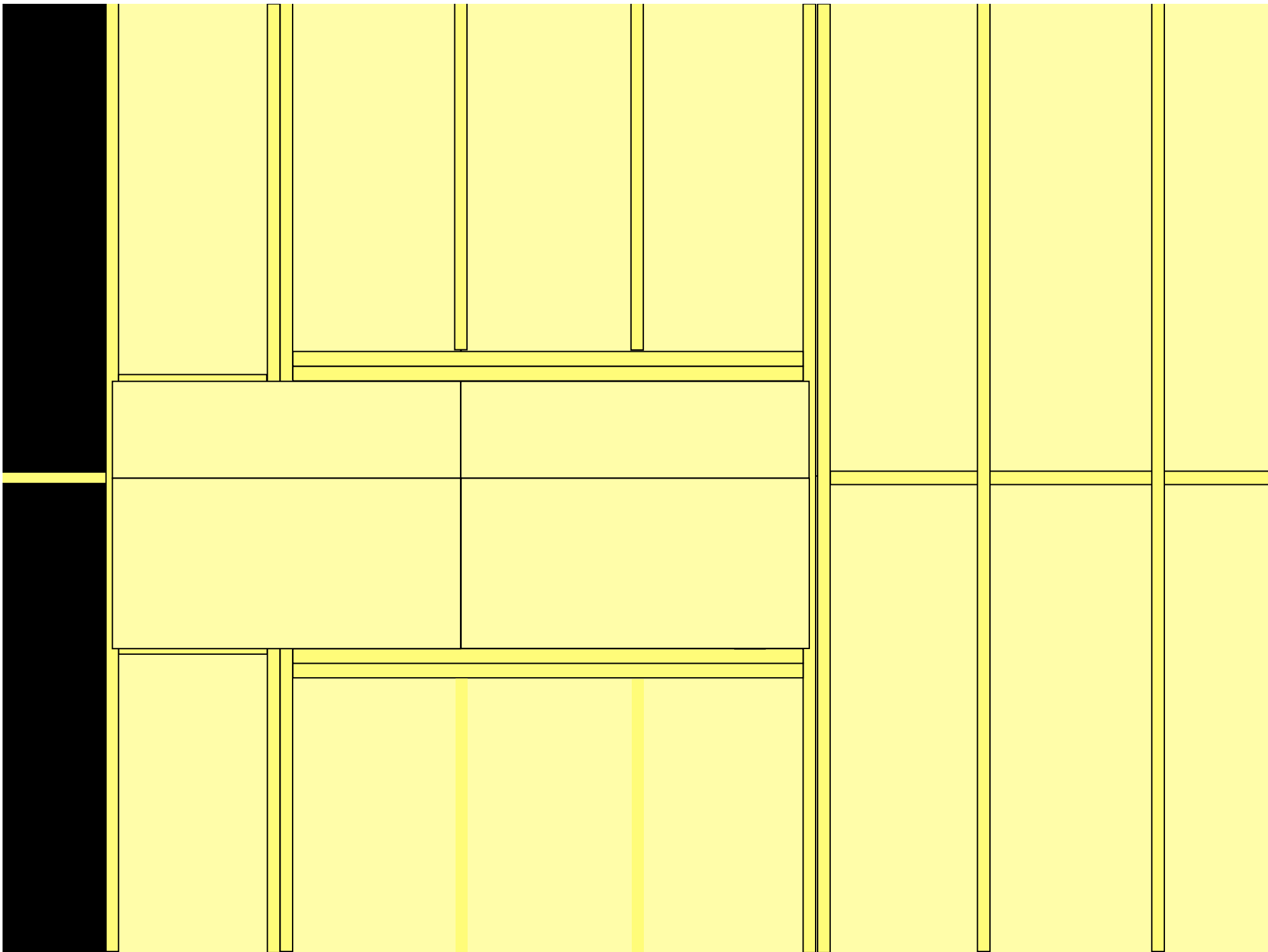
Multiple section simplifies design

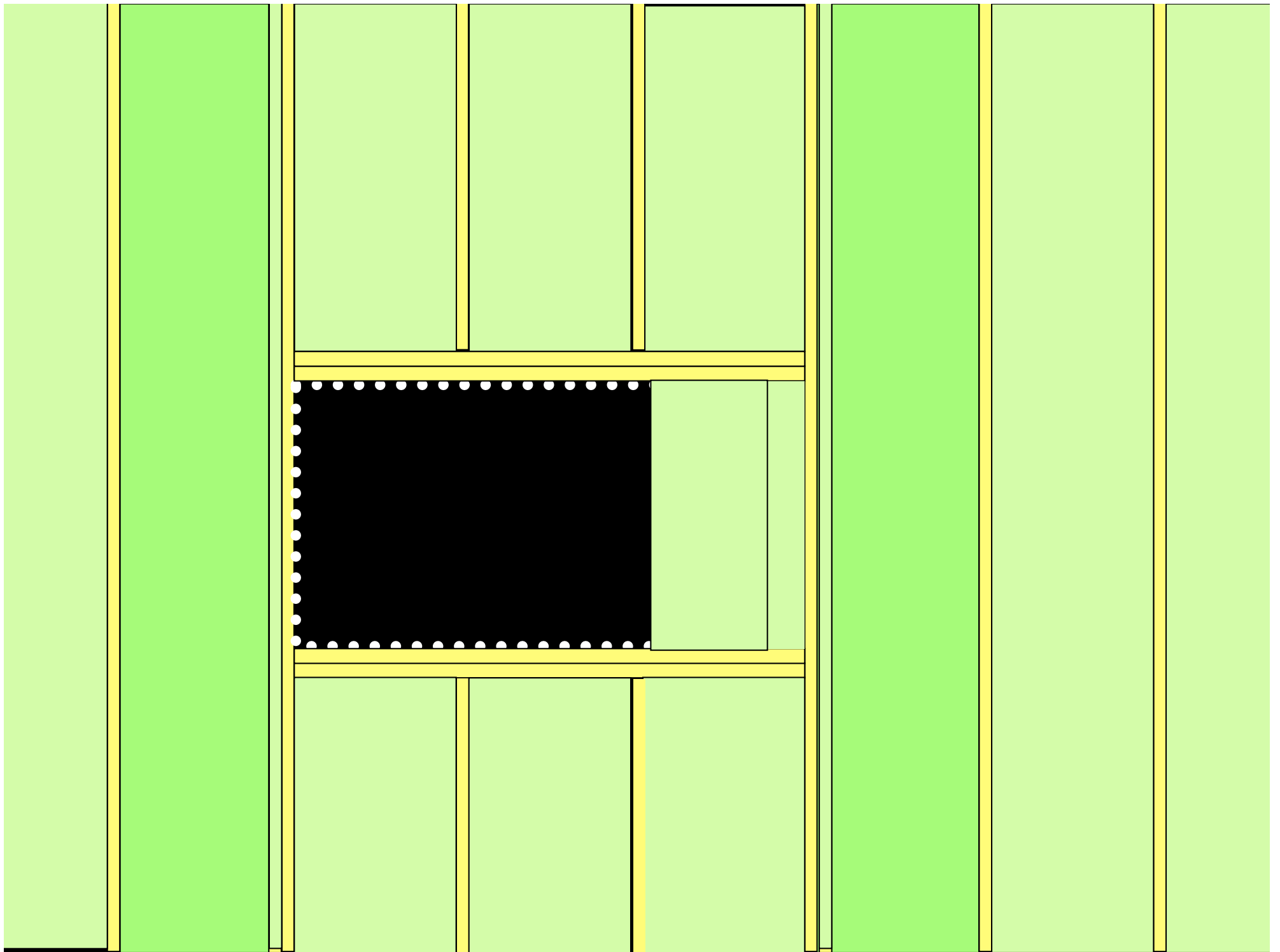
Trimming of openings flat or pitched roof section

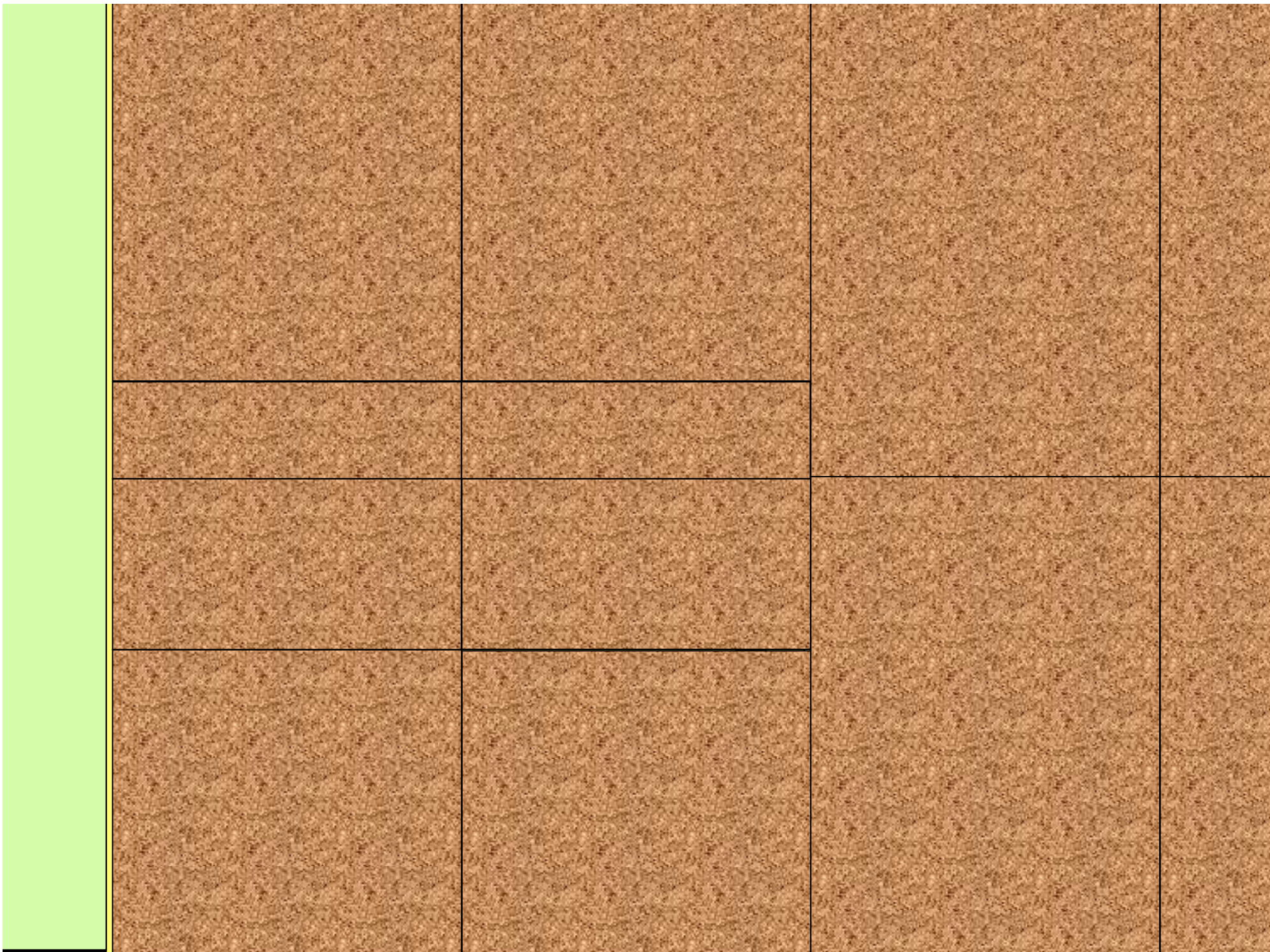


Lazy Structural Design: less calculation, more structure
Avoid over design of structural supports or around openings
Avoid creating wide cold bridges through insulation
chopping standard width insulation rolls: more waste









Design to Reduce Waste

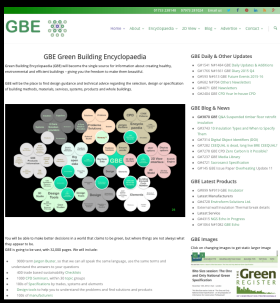
Another GreenSpec CPD to download soon



Reused wood better than new

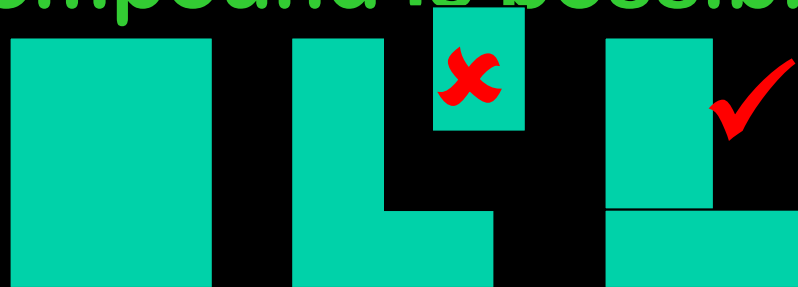
**BedZED Beddington Sutton Architect: Dr Bill Dunster,
Reclaim: BioRegional ReCLAIMED**

© 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

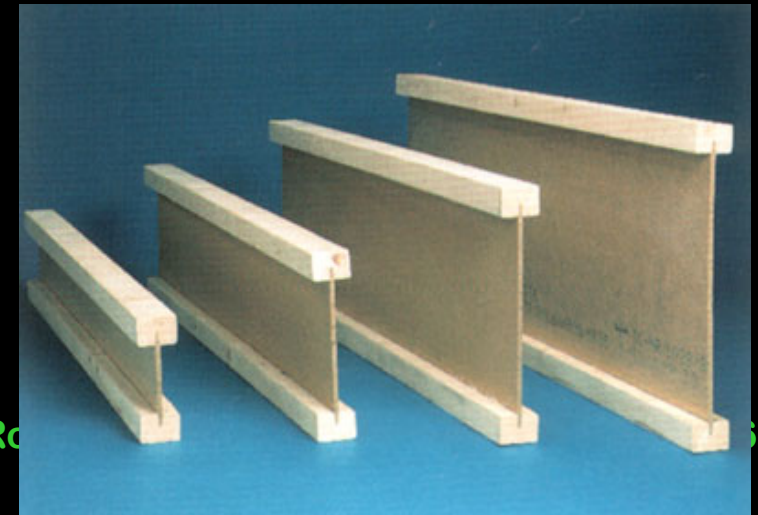
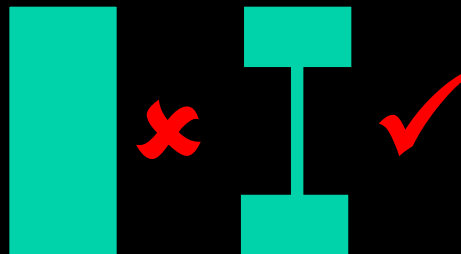


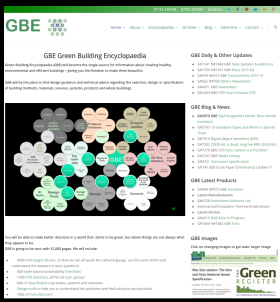


Reduce Demand



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

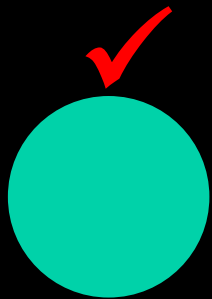




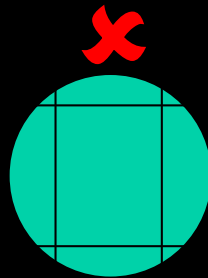
Reduce Demand



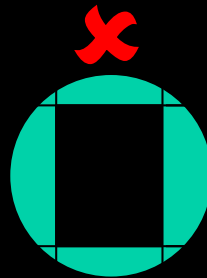
- Consider use of materials as found:
- Round pole structures
- Or compound sections without waste
- Or use off-cuts in cladding



Roundwood



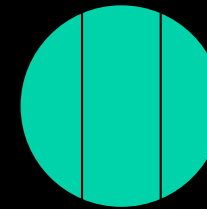
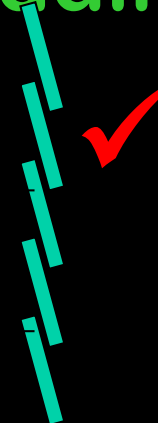
Cut



Waste

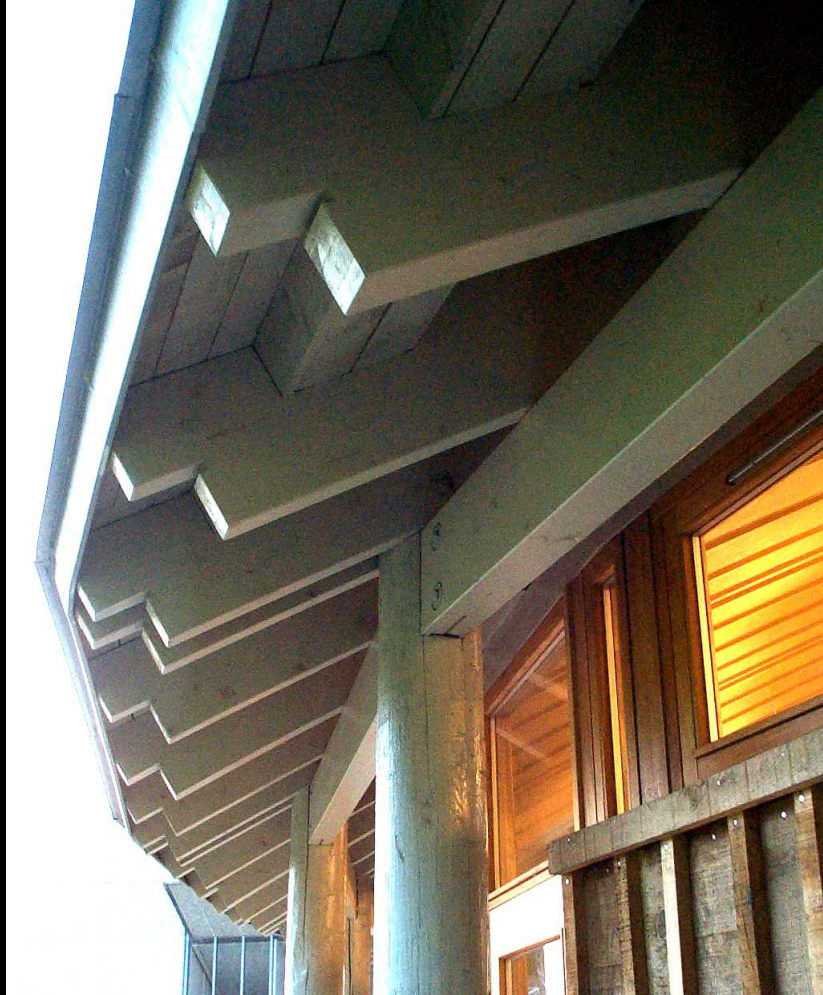


Wood Boarding



Cut Reassemble





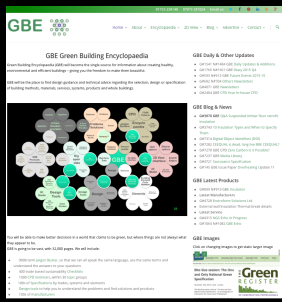
**Layered Construction:
Simplifies details and
avoids interfaces:**

**Ventilation zone above
insulation.**

**Don't puncture Damp
proof membrane, Gas
proof membrane,
Vapour barrier,
Breather membrane &
Air tightness layer.**

**Add services zones to
avoid complications**

Aberystwyth Arts Centre: Architect: Smith Roberts: Peter N Roberts



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- **Brian Murphy BSc Dip Arch (Hons+Dist)**
 - Architect by Training
 - Specification Writer by Choice
 - Environmentalist by Actions
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- Launched www.greenspec.co.uk 2003
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- LinkedIn:
- Google+:
- Created: 06/11/2007, Updated: 12/06/2016