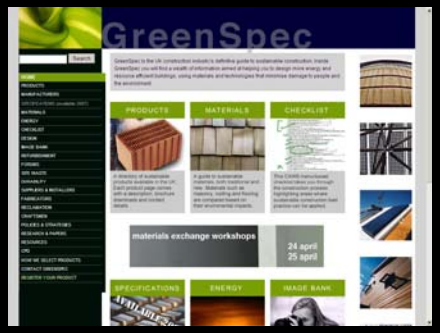

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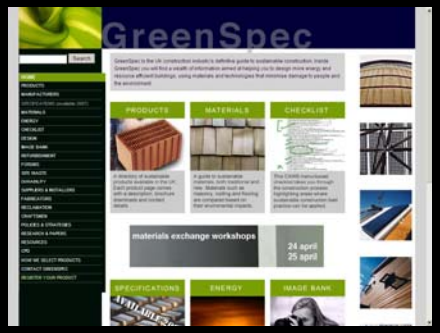
Suspended Upper Floors

(23) Floors Galleries

LSBU Tech & Env 2 Lecture

- Domestic, Small & Medium size buildings
- Construction methods, materials, services and systems
- Upper Floors



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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

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Floor Actions

- Gravity: downward pull
- Wind: Motive force (suction), pressure buffeting, Destructive, Penetrative
- Rain: Moisture deposition, penetration
- Snow: Moisture deposition, loading, slush carried in, material degradation
- Moisture vapour: permeation, condensation, insulation impaired
- Sun: Temp variation, thermal movement, heat gains, Chemical decomposition
- Dirt and Dust: infiltration, deposition, surface pollution, surface erosion
- Chemicals: surface corrosion, disintegration, decomposition
- Sound: Noise nuisance, impact, rattle, creaking,
- Attack: Manual, Ballistics, Bomb Blast
- Thermal: heat loss, cold to touch, radiant coolth, condensation,
- Deposits: chewing gum, staining, adhesion, trip hazard, surface texture penetration
- Gases: Ground gases: Radon (Radio Active), Methane
- Moisture: flood water, ground water rising, capillary attraction, moisture transfer

Floor Reactions

- Gravity: Support
- Wind: rigidity, resilience, sealing, air tightness layers and detailing
- Rain: deflection, impervious skin, absorption and drainage, sealing
- Snow: deflection, impervious skin, absorption and drainage, sealing
- Moisture vapour: resistance, hygroscopicity, permeability, breathing, moisture mass
- Sun: movement joints, insulation, shielding, invulnerable materials
- Dirt and Dust: repulsion, exclusion, shielding, 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
- Deposits: smooth impervious surface, flush impervious joints,
- Gases: Gas/Damp proof membrane linked to G/DPC
- Moisture: Elevation of floor above flood plain, Separation, water resistant materials, Damp proof membranes linked to DPC

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 heave
  - Chemical

Principles of Element Design

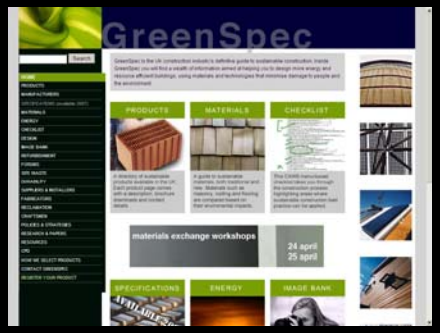
- Acoustic Performance
  - Resistance, absorption
- Fire Performance
  - Surface spread of flame
  - Fire Resistance
- Security
- Inspection and maintenance
  - Inside & out
- Pest infestation
  - Termites,
  - Termite Barriers
- Rising damp
  - Barriers
  - Capillary Attraction
  - Hygroscopic or Hydrophobic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

Suspended upper floor: Opportunities

- **Joist zone can include:**
  - Thermal insulation and/or mass between floors
  - Acoustic Insulation and/or mass
  - Fire insulation
- **Joist zone can include:**
  - Services cable and pipes
    - **But layering suggests simplification of interfaces and services installation**
    - **Drainage pipes best straight down**
    - **Wiring better in a lower cable zone**
- **Suspend above flood level living rooms at upper level**
  - Might avoid flood damage

Structural Floor

- Timber Deck
  - Joists or compound joist and board or sheet
  - 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



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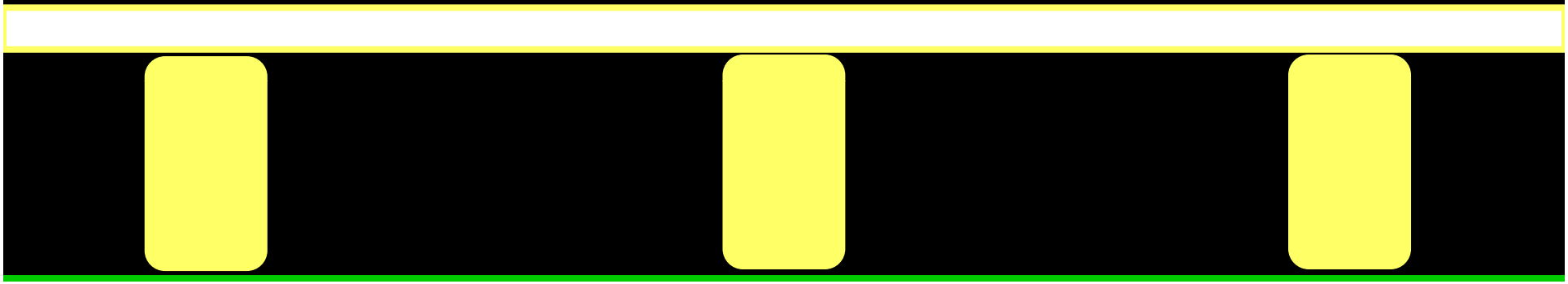
Timber Suspended Upper Floors

(23) Floors Galleries

Suspended Upper floor: Traditional

- External and internal walls offer support
- DPC Damp proof course on mortar bed and lapped joints
- Timber wall plate
- Timber Joists
  - No insulation,
- Wooden boarded floor: open or T&G jointed
  - Air leaky floors
- Plaster lath and plaster ceiling

Suspended Floor Joists

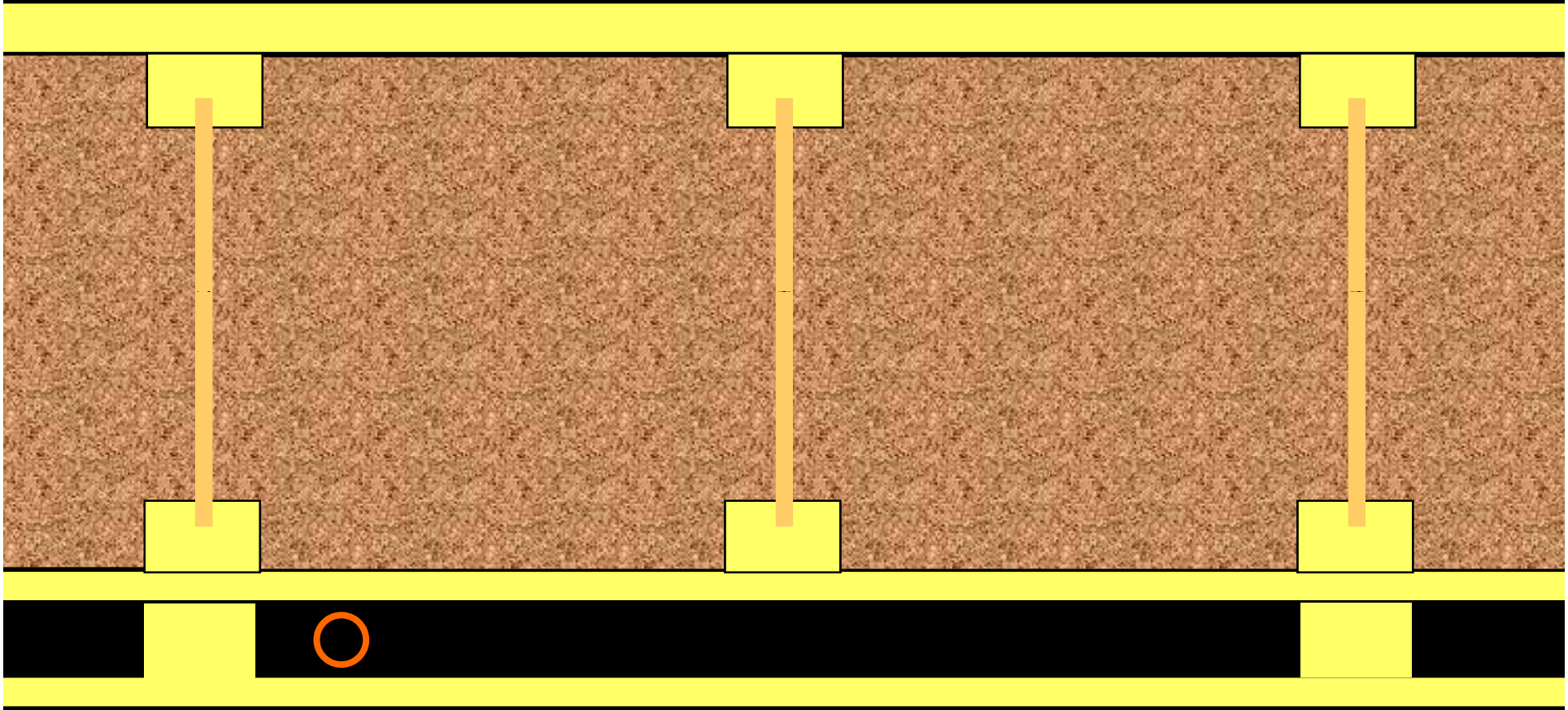


Simple design and construction

Suspended Floor types: Eco

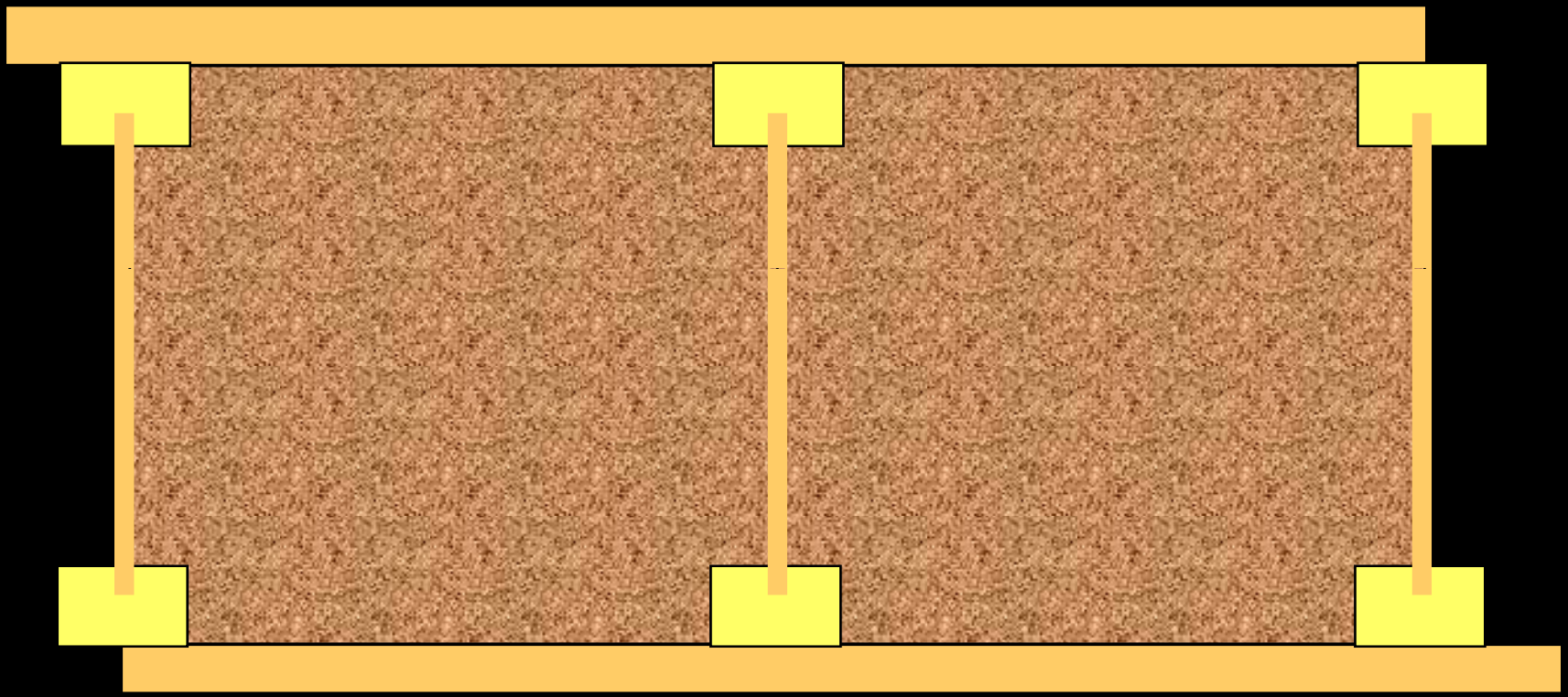
- Suited to load bearing walled or framed buildings
- Frames from column and posts
- Timber I beams minimise resource use
- Well insulated for warmer climate (2050)
- Thermal insulation
- Airtight for acoustics
- Thermal mass can be added

Compound Floor joist ‘I beams’ to accommodate more thermal insulation



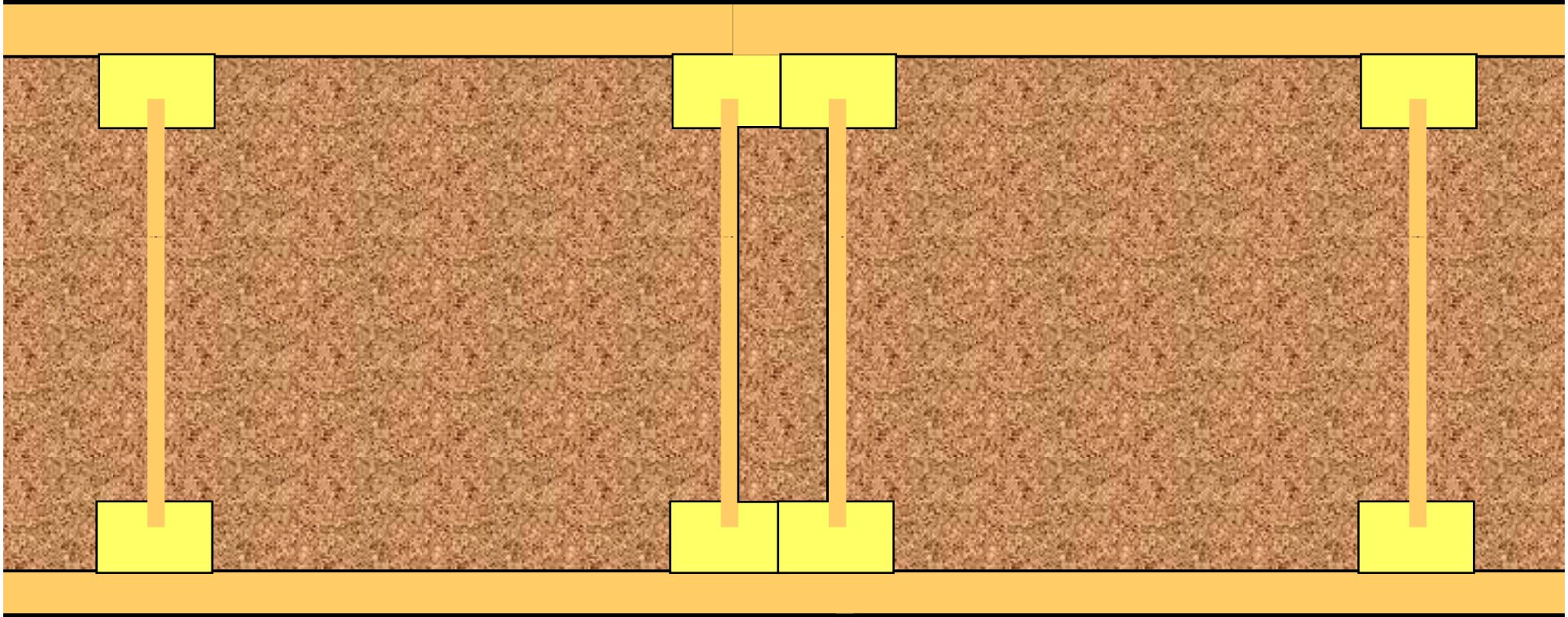
Compound section reduces amount of materials used and weight
UK products promote stiffness, creak-free, silent floors
Layering: Services Zone simplify installation & avoid penetrations

Compound floor joist ‘I beams’, inner and outer boards and thermal insulation



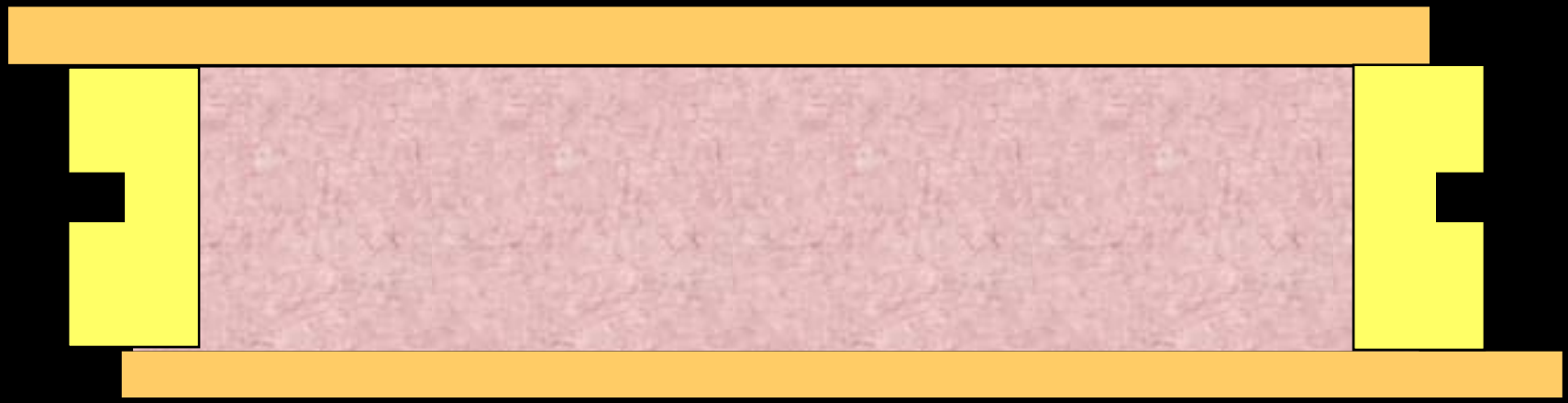
Prefabricated suspended floor panel

Compound floor joist ‘I beams’, inner and outer boards and thermal insulation



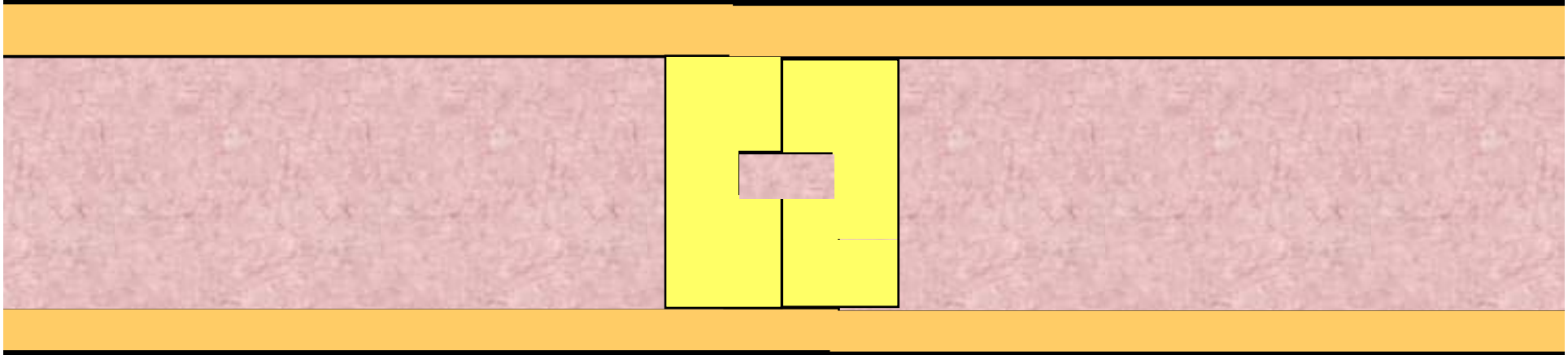
Prefabricated suspended floor panel

SIP Structural Insulated Panel



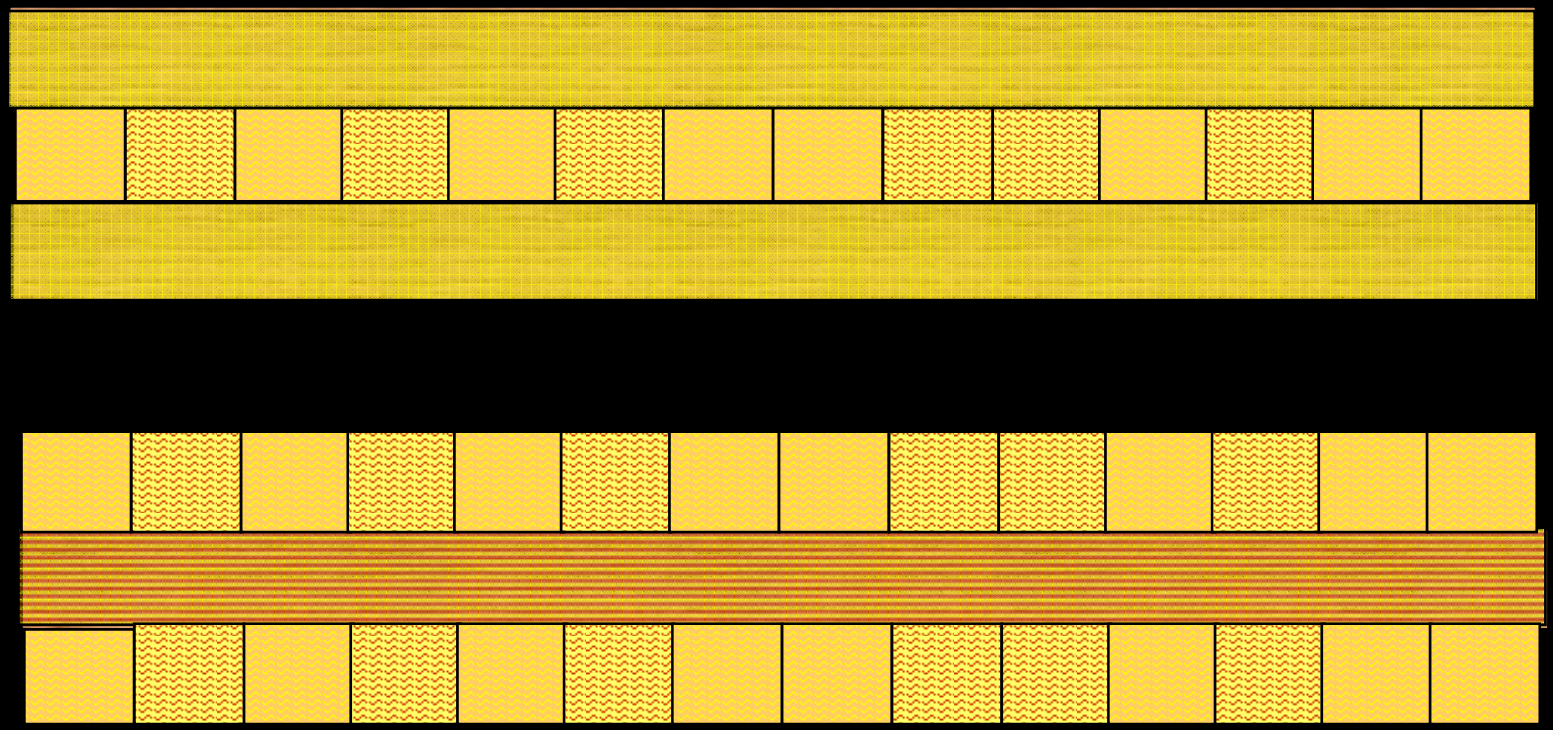
Prefabricated suspended floor panel

SIP Structural Insulated Panel



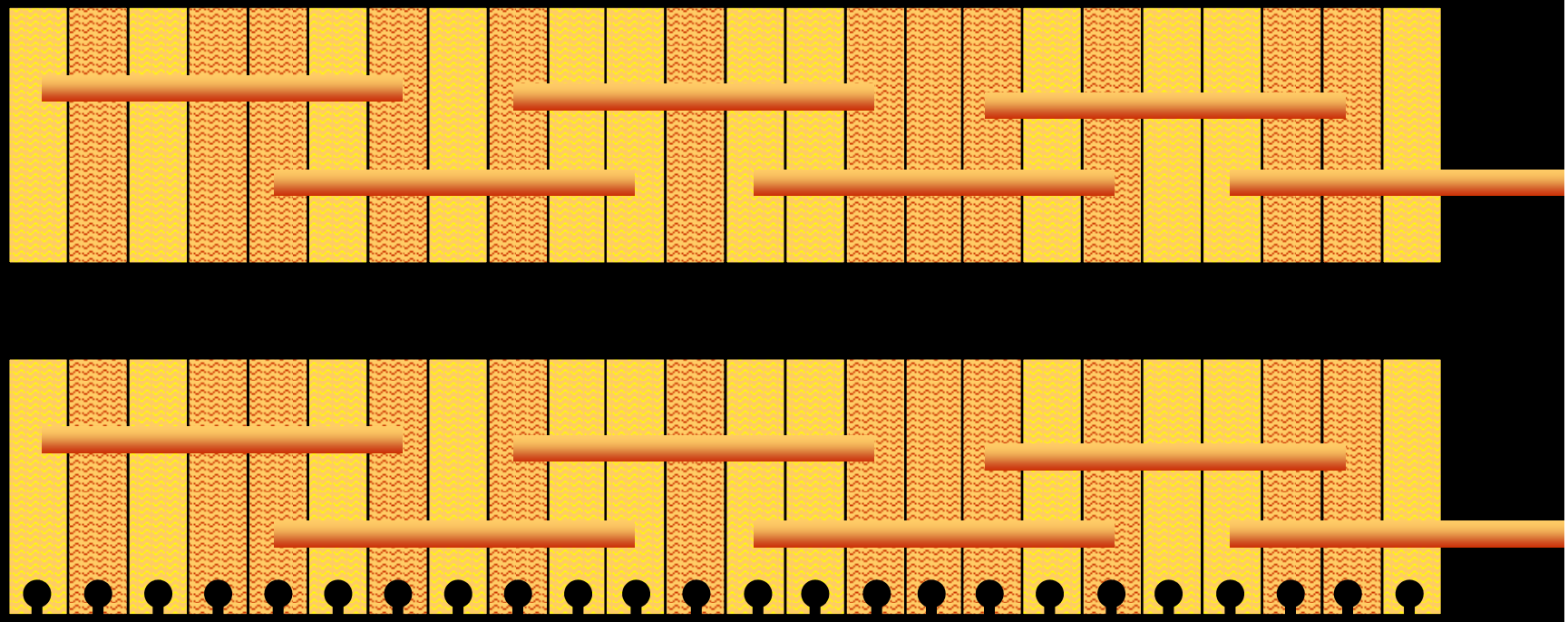
Prefabricated suspended floor panel

Load-bearing Structural Timber Panel Floor

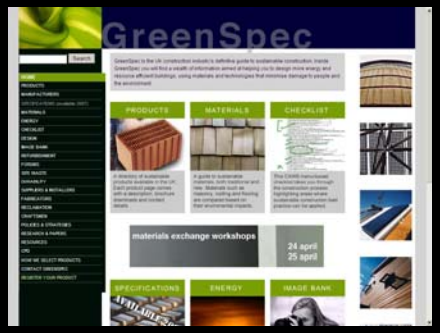


Prefabricated suspended floor panel softwood lamina or plywood core option

Load-bearing Laminated Structural Timber Floor Panel: loose dowelled



Prefabricated upper floors
with acoustic absorber slot option



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Acoustics: Suspended Floors

(23) Floors Galleries

Different Floor Structures

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

Suspended upper floor

- Timber Floor boarding
- Floating floor underlayment
- Cellulose fibre board
- Underlayment
- Acoustic density bricks in floor
- Laminated Timber floor planks

Fired clay cellular block walls

Familiar in Mediterranean climate
Thermal insulation and load bearing capacity:
Mortared bed joints
Plastered internally
Rendered externally
Low load capacity
Thermal mass
Acoustic mass

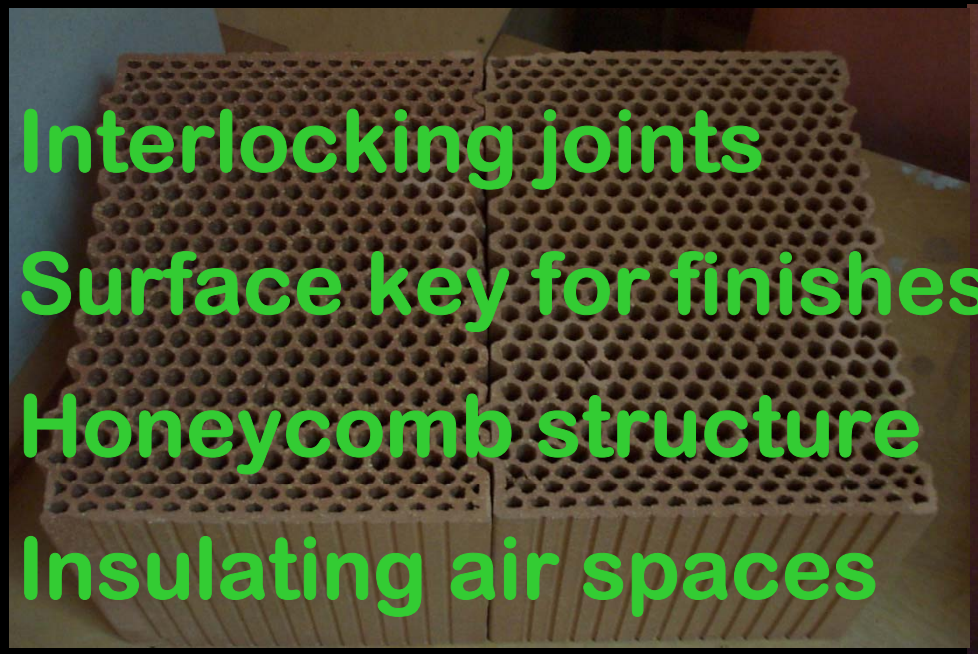
Construction Resources Showrooms Southwark London

Thermal & Acoustic Mass

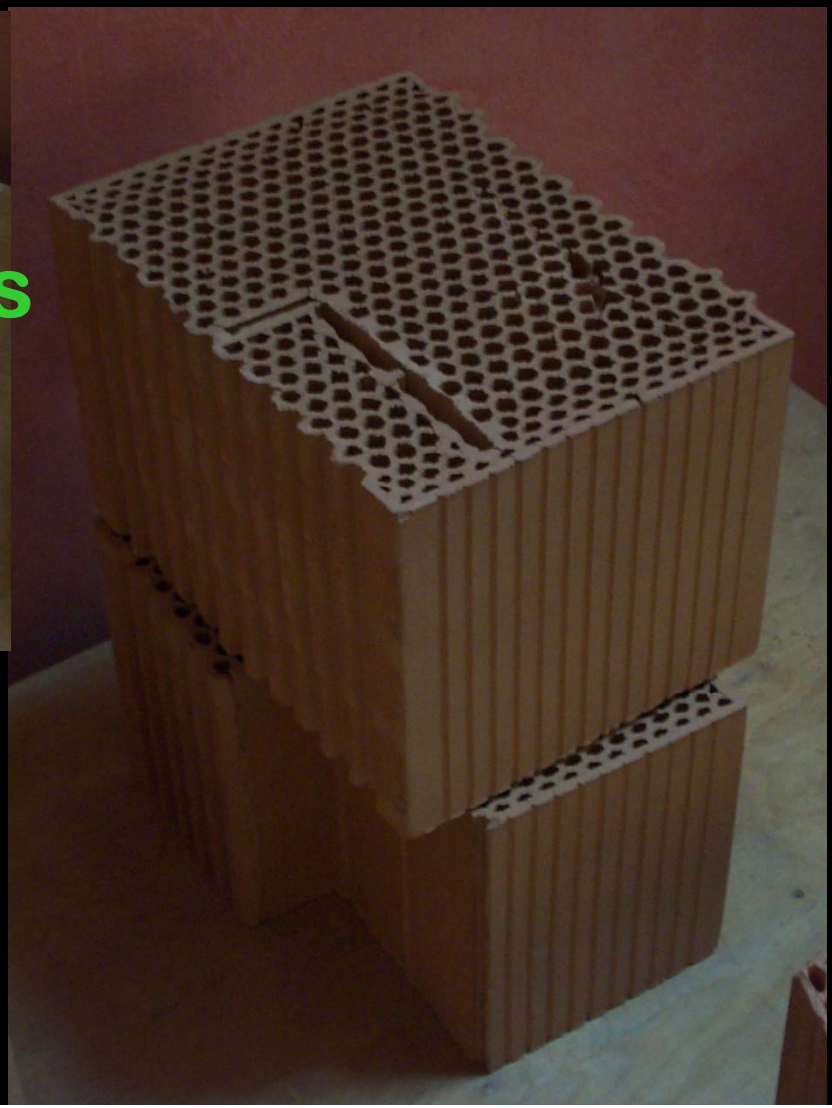
Acoustic and thermally insulating fired clay honeycomb blocks in walls and floors adds Inter-seasonal thermal mass

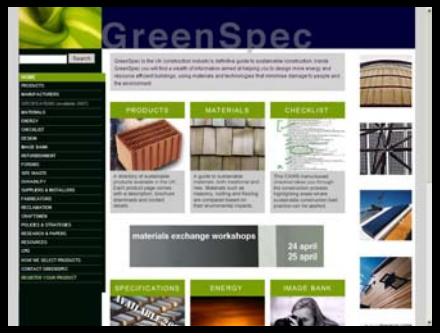
Construction Resources Showrooms Southwark London

Cellular fired clay blocks



- Interlocking joints
- Surface key for finishes
- Honeycomb structure
- Insulating air spaces
- Knock out panels





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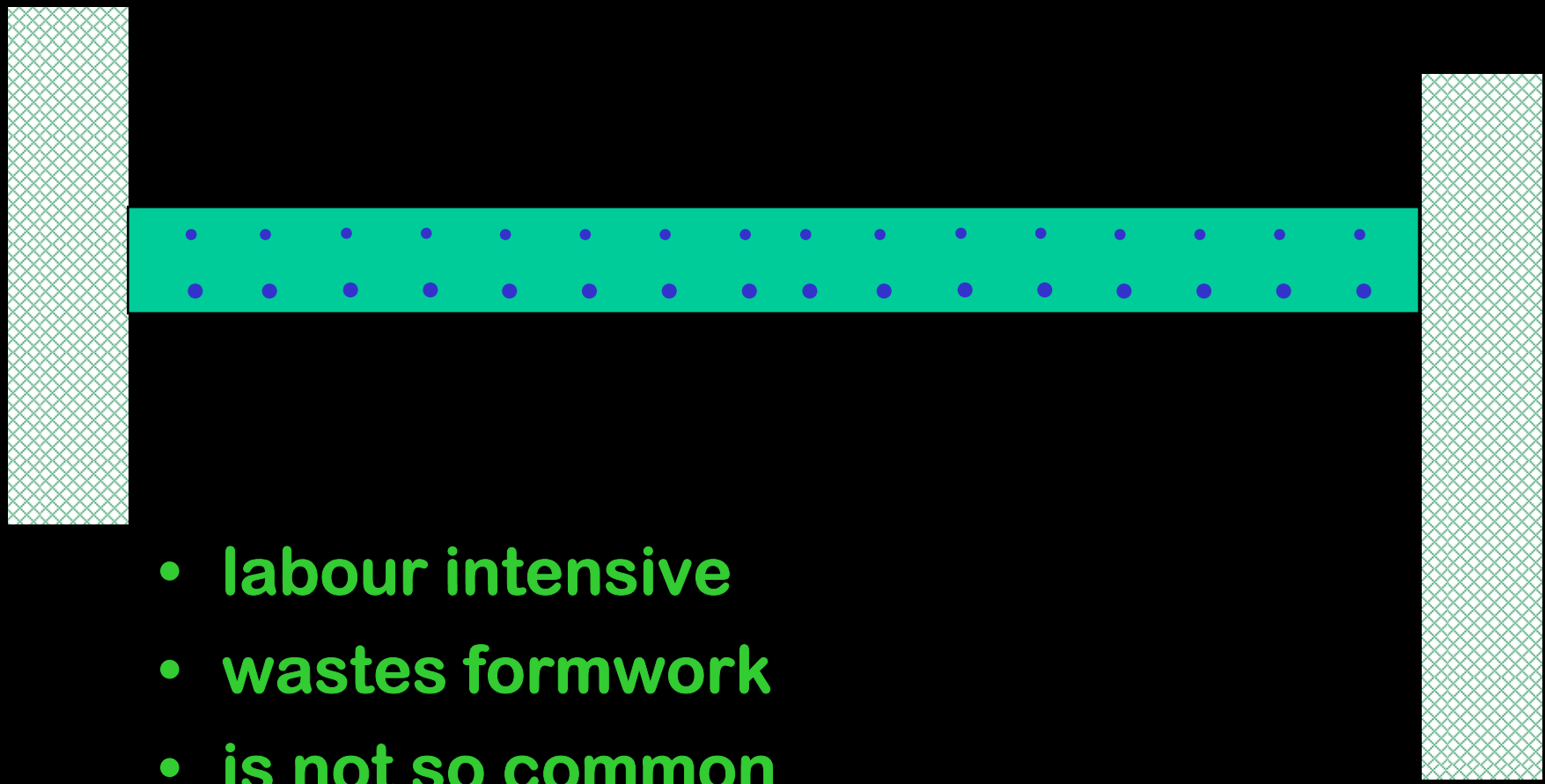
Concrete Suspended Upper Floors

(23) Floors Galleries

Suspended GF Types: Economic & common:

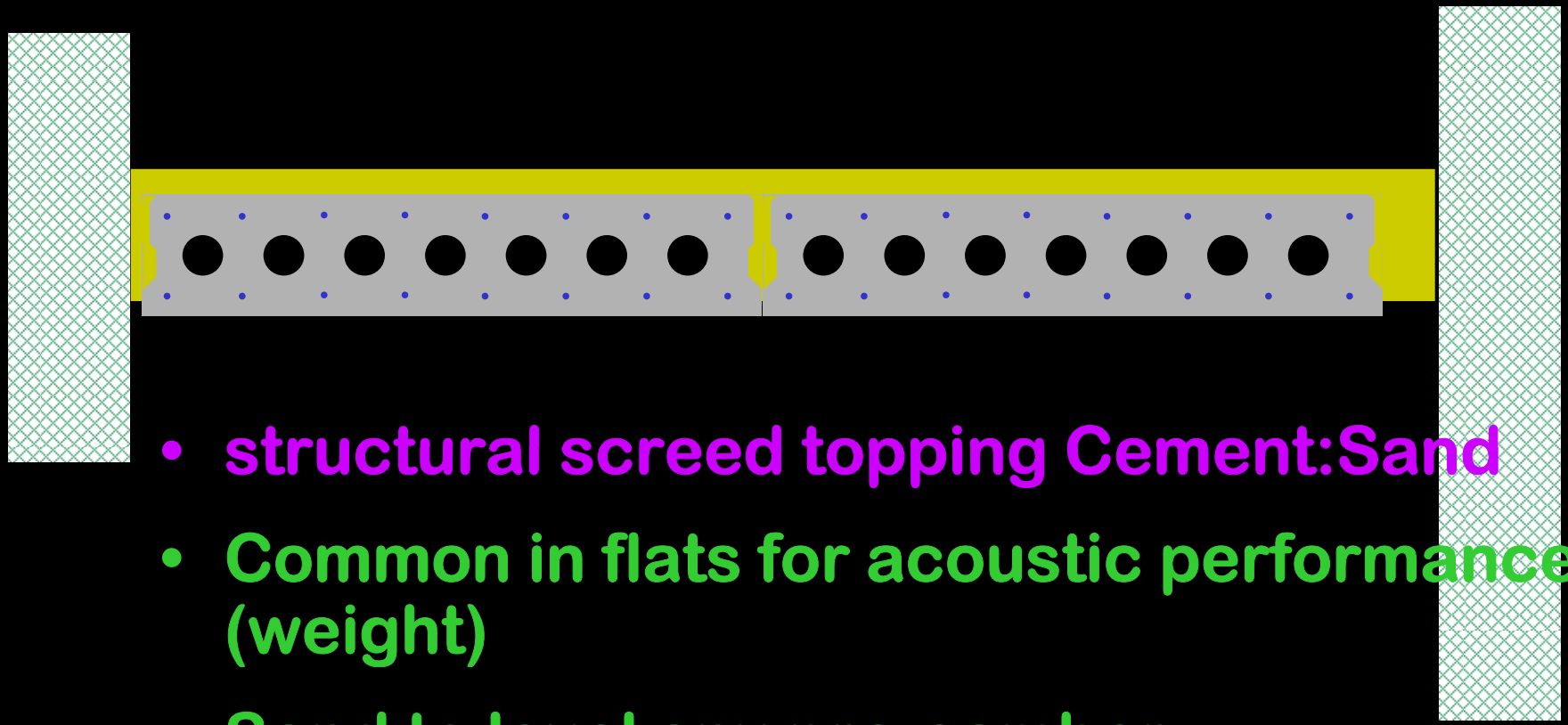
- Suspended insitu concrete is labour intensive wastes formwork and is not so common
- Precast concrete plank and structural screed topping Cement:Sand
- Precast concrete beam and concrete block with topping
- Hybrid mixtures of the above
- Common in flats for acoustic performance (weight)
- Sand to level any pre-camber
- Holes drilled (cored), cut or trimmed

Suspended insitu concrete



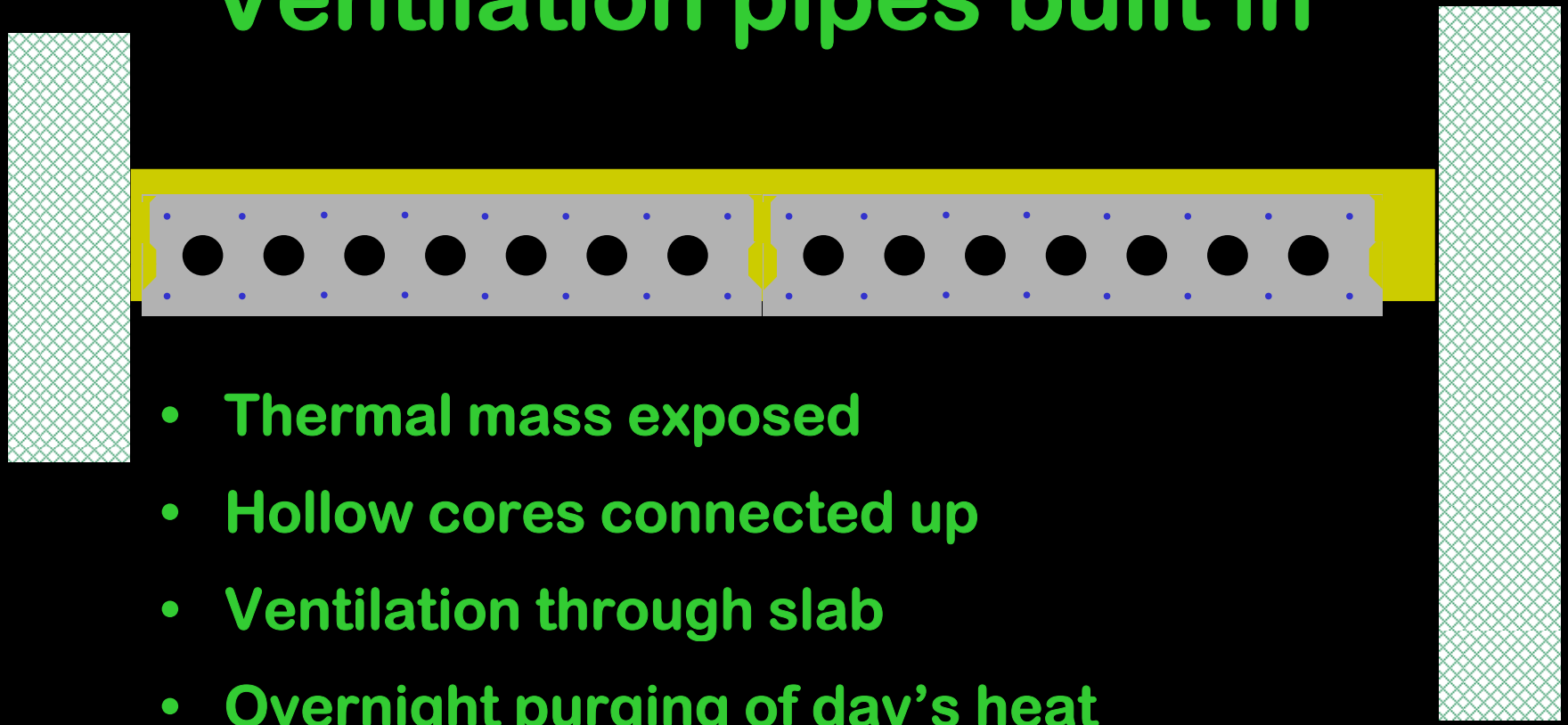
- labour intensive
- wastes formwork
- is not so common
- Holes formed, late holes drilled (cored)

Precast concrete plank floor



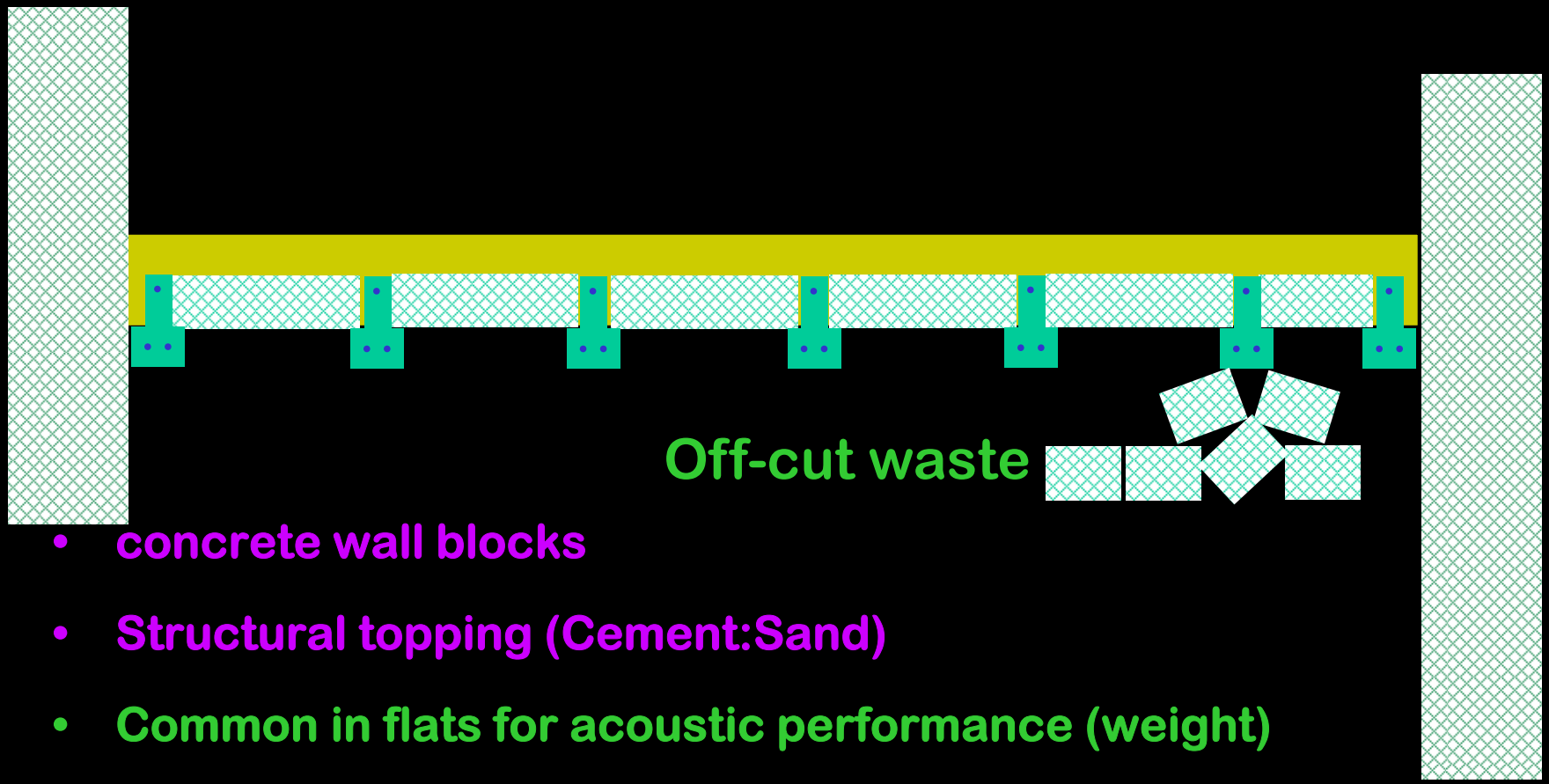
- structural screed topping Cement:Sand
- Common in flats for acoustic performance (weight)
- Sand to level any pre-camber
- Services holes drilled (cored), cut or trimmed

Precast concrete plank floor
Ventilation pipes built in



- Thermal mass exposed
- Hollow cores connected up
- Ventilation through slab
- Overnight purging of day's heat
- So soffit is cool at beginning of day
- No suspended ceilings to hide thermal mass

Precast Beam and Block floors



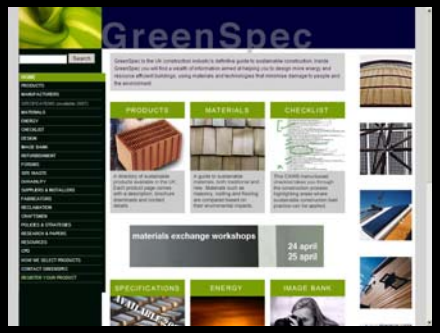
- concrete wall blocks
- Structural topping (Cement:Sand)
- Common in flats for acoustic performance (weight)
- Sand to level any pre-camber
- Holes cut or trimmed

Metal Trough & Insitu EcoConcrete

- Requires framed superstructure usually steel
- Steel Permanent formwork deck provides access for labour
- Insitu eco-concrete poured onto trough and levelled
- Steel and eco-concrete bond and together to make strong thin floors
- Potential reduction in storey heights

EcoConcrete

- Reduced OPC Ordinary Portland Cement content (reduced CO^2 production)
  - GGBS Ground Granulated Blast-furnace Slag Cement (Slag)
  - PFA Pulverised Fuel Ash
- Reduced Primary or Virgin Aggregates (sand and gravel)
  - Secondary aggregates (waste or by-product)
  - Recycled aggregates
  - Recycled concrete aggregates
  - Recycled other materials (glass, plastics, etc.)
- Mains drinking water supply



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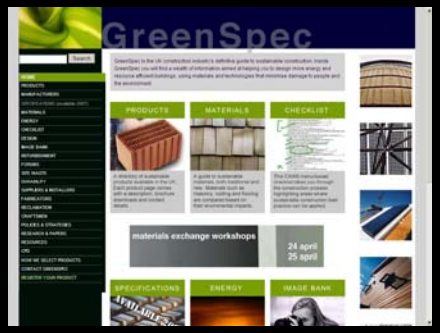
Acoustics: Suspended Concrete Floors

(23) Floors Galleries



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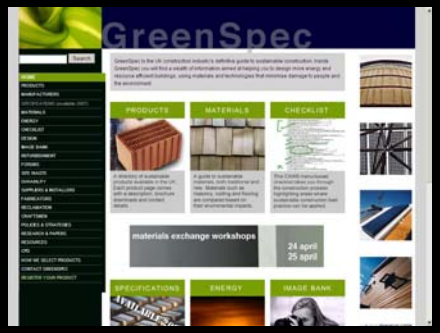
- Insitu concrete construction is dense
- Insitu concrete construction is airtight
- Airtight & dense = good acoustic floor
- But
- Flanking sound around edges
- Noise passes along in floor
- Air and noise pass through cavity



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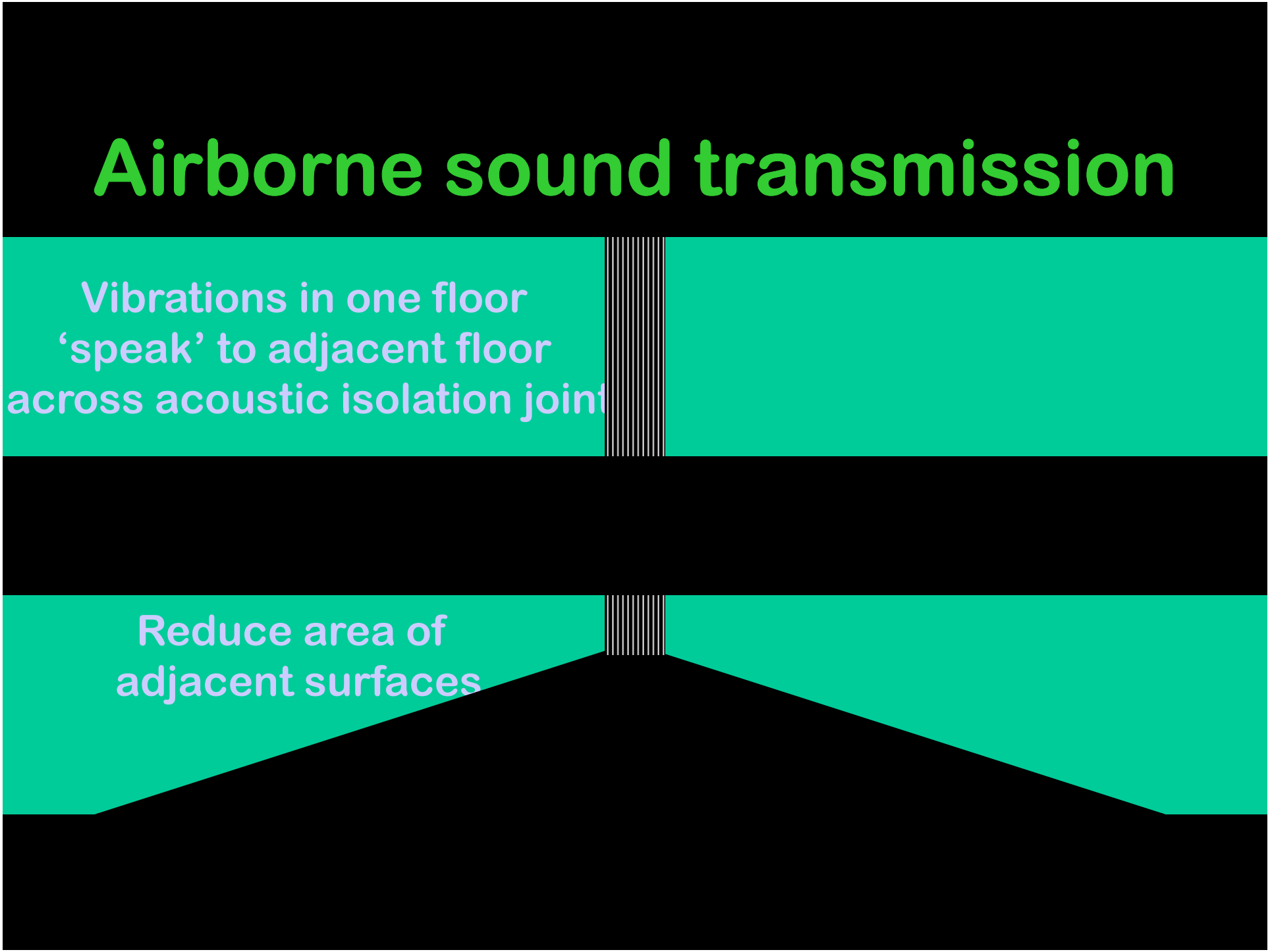
Acoustic bridges

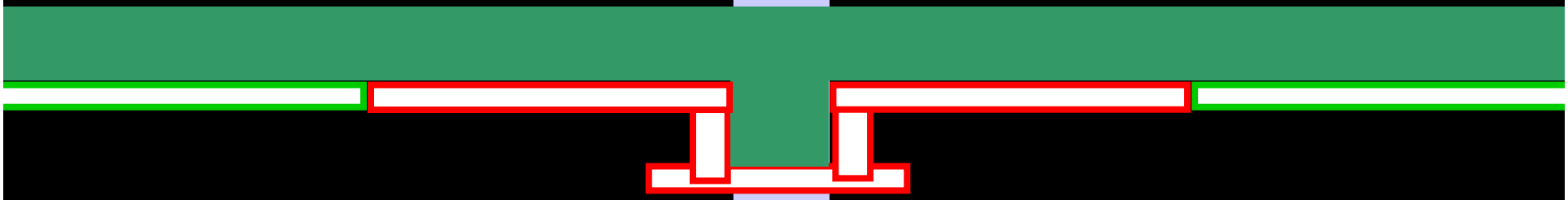
- air passage through construction linking between rooms or from inside to outside
- Acoustic conduction route
- Isolation joints to separate floors
- Surfaces either side of a gap can also ‘talk’ to each other
- Reduce floor edge thickness at isolation joints

Airborne sound transmission



Resource Efficiency Concrete upper floors

Insitu concrete floor slab formwork



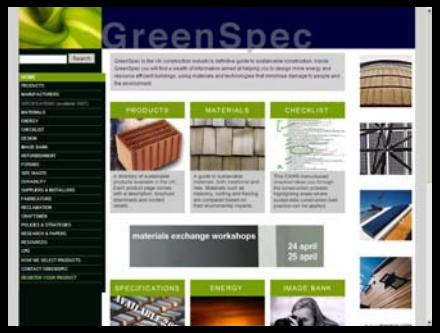
Down-stand beam complicates formwork
Creates off-cuts and waste

Flat soffit allows use of modular formwork
Assuming the building grid reflects their size

Acoustic Isolation Joints

Metal Trough & Insitu EcoConcrete

- Steel Permanent formwork
- No plywood formwork waste
- Potentially thinner floor but large steel support beams,
- castellated for passage of services



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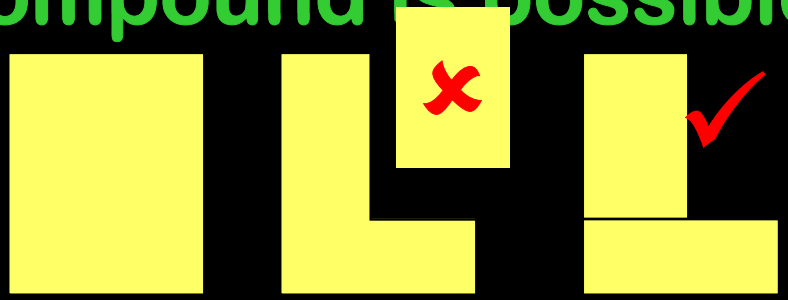
Resource Efficiency Timber Upper floors

Reused wood better than new

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

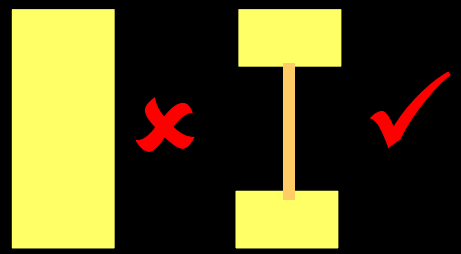
Reduce Demand

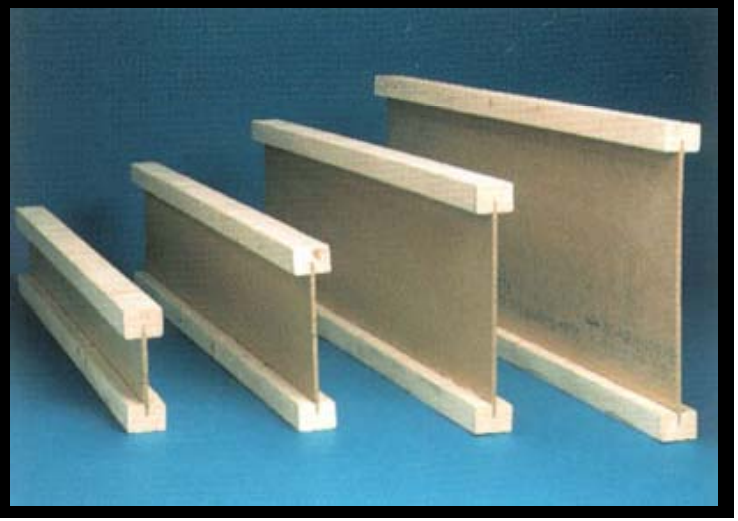
- Don’t over design structure
- Except if long design life demands it
- Don’t oversize
- Don’t cut section from solid if compound is possible



Reduce Demand

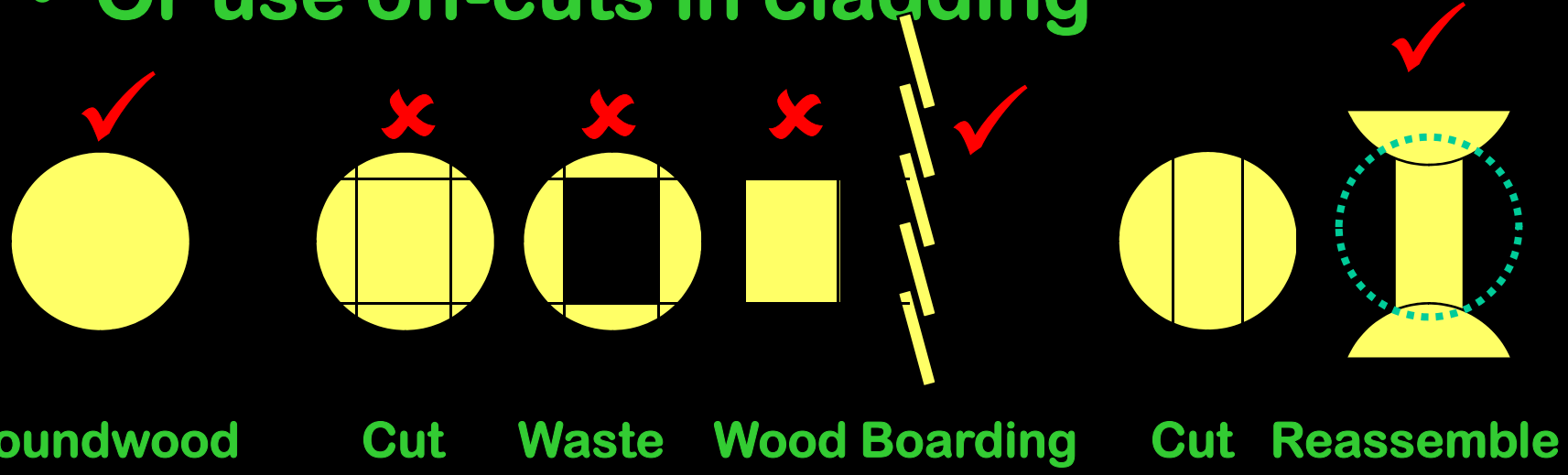
- Don’t cut section from solid if compound is possible
- Reduce solid sections to compound to reduce weight and materials used



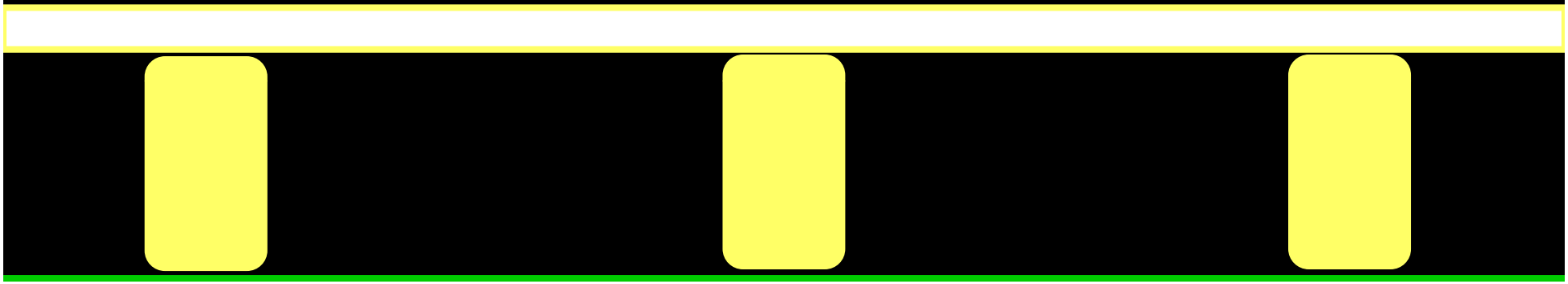


Reduce Demand

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



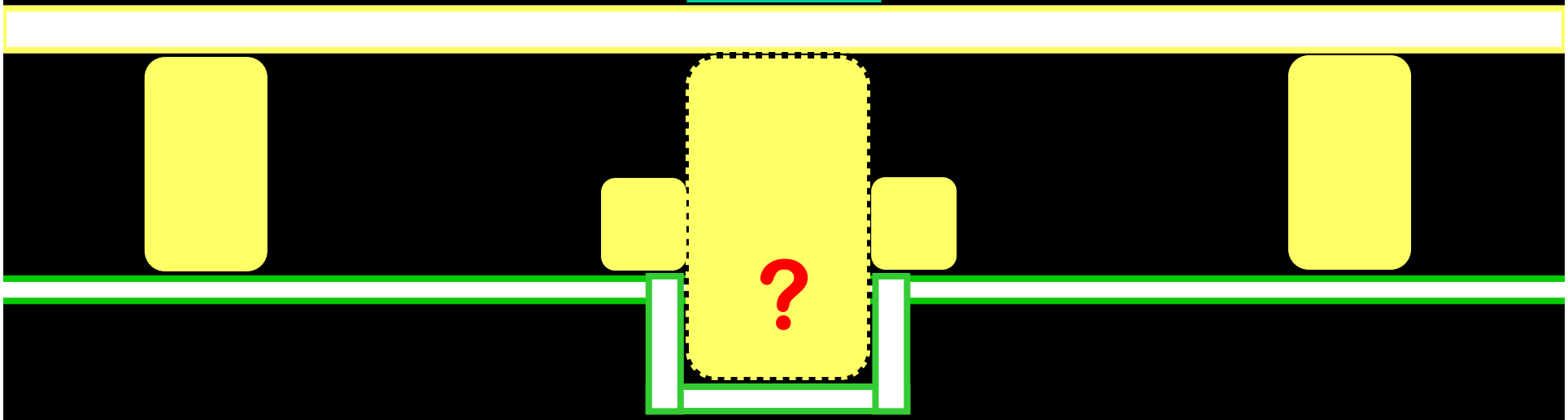
Suspended Floor Joists



Simple design and construction

Floor Joists/Beams

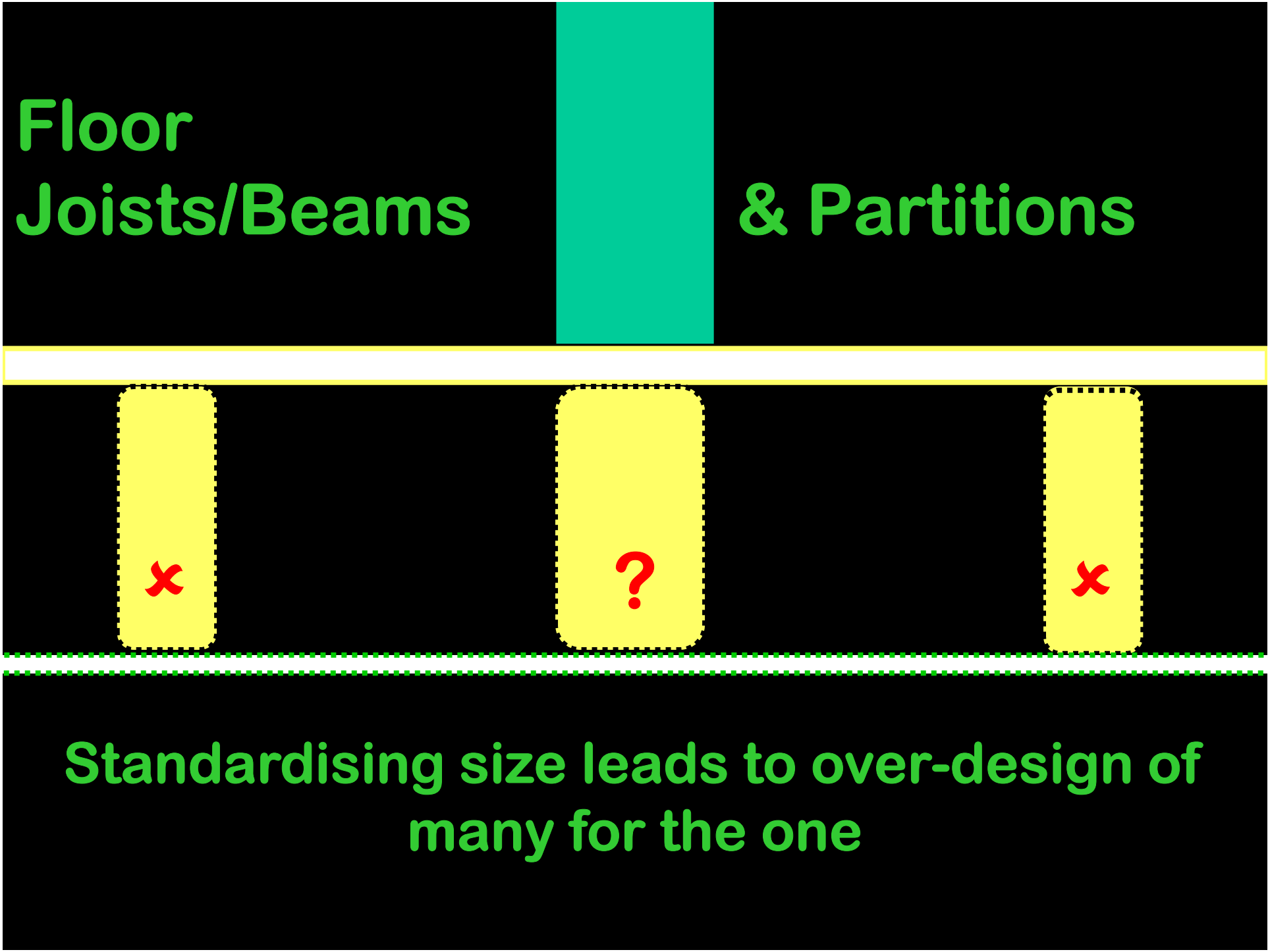
& Partitions



Different section complicates detail

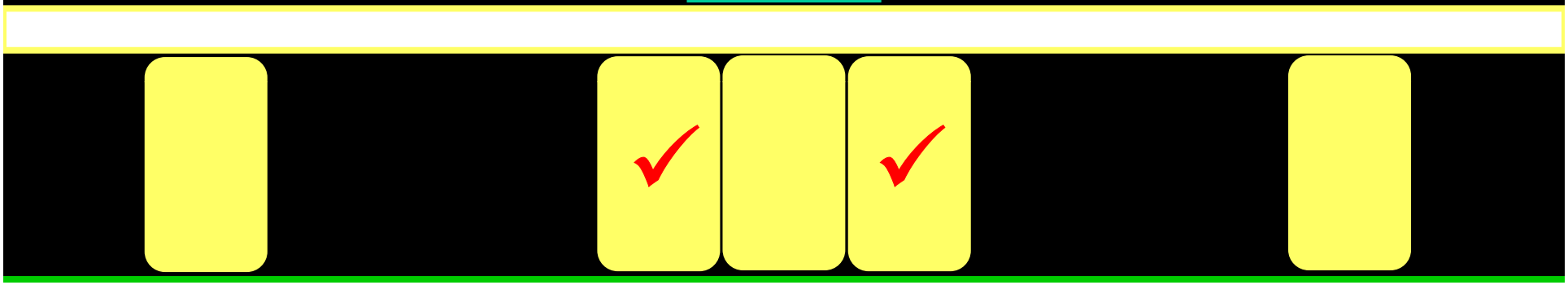
Creates off-cuts and waste

Changes appearance below


Floor
Joists/Beams
& Partitions
x
?
x
Standardising size leads to over-design of many for the one

Floor Joists/Beams

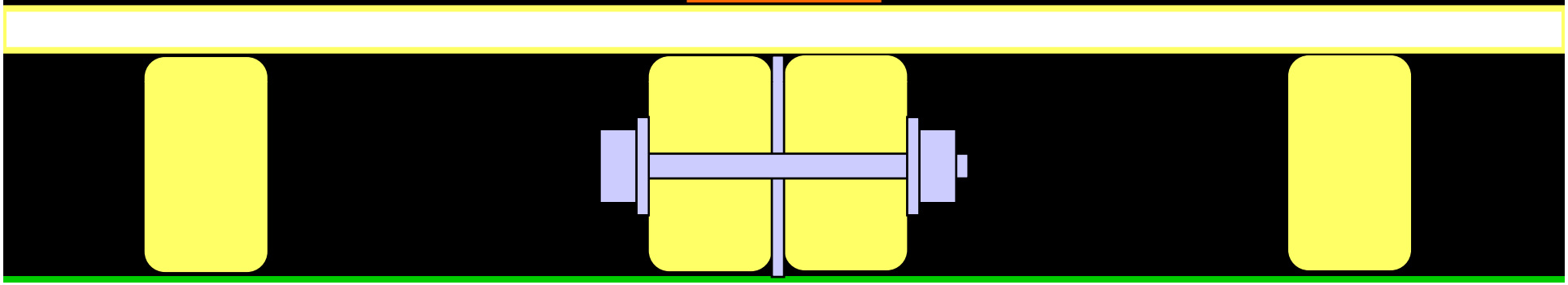
& Partitions



Multiple section simplifies design and construction

Floor Joists/Beams

& Partitions

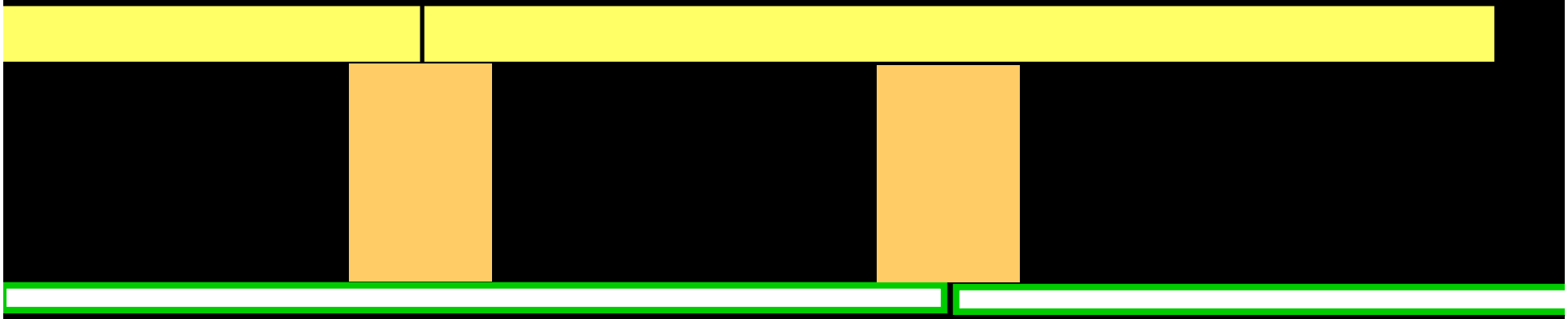


Multiple section with flitch plate of steel bolted together

Suspended upper floor

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

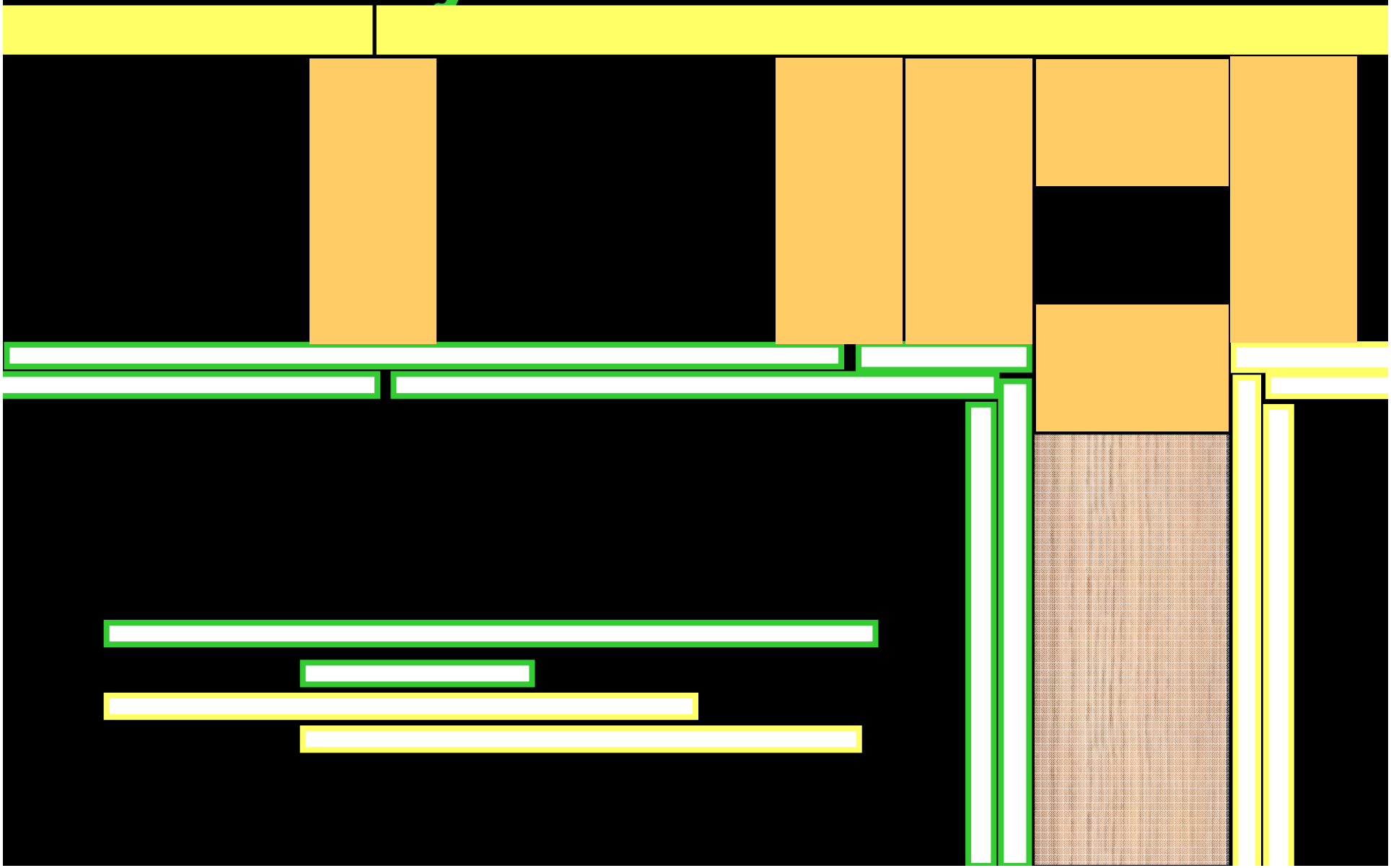
1 layer or 2?



Tolerances? Moisture resistance
Nothing gained

Robustness? Fire Performance?
Acoustic performance?

2 layers = 2 x materials &
2 layers = 2 x off-cuts



1 thicker layer of different grade = 1 x off-cuts