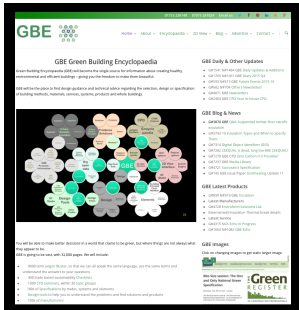

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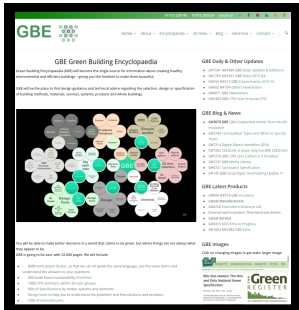
(11) Ground

CI/SfB (11) Ground

Profile, Composition, preparation, water

Architecture Part 1 Year 2
LSBU Tech & Env 2 Lecture

- Domestic, Small & Medium size buildings
- Construction methods, materials, services and systems
- Ground, inspection, clearance, preparation



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Performance Requirements

Principles of Element Design

Performance Design

- Establish the Performance requirements of the building
- Then design the elements to meet them
- E.g. What is the design life?
- This forces us to address durability
- And gives an opportunity to consider whole life costs and life cycle analysis
- We also need to consider the energy demands of the building during that life

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. (Oxon) ARA, 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

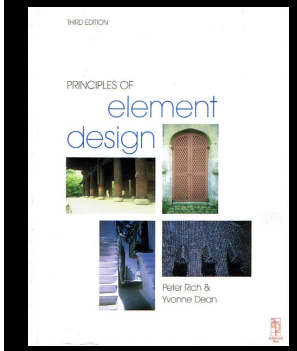
9 780750 631136

Actions

- Gravity: downward pull
- Wind: Motive, wind scour, surface drying, dust generation
- Rain: Moisture deposition, penetration, saturation, ground heave, frost heave, percolation,
- Snow: Moisture deposition, loading
- Moisture vapour: permeation, material degradation,
- Sun: Temp variation, drying shrinkage, thermal movement, heat gains
- Dirt and Dust: infiltration, deposition, surface pollution
- Backfill waste: chemical liquid and gases
- Chemicals: corrosion, disintegration, decomposition
- Gases: Radon percolation, Methane percolation
- Mechanical: Drilling, excavation, disturbance by vehicles
- Thermal: heat loss, radiant coolth, energy source (warmth or coolth)

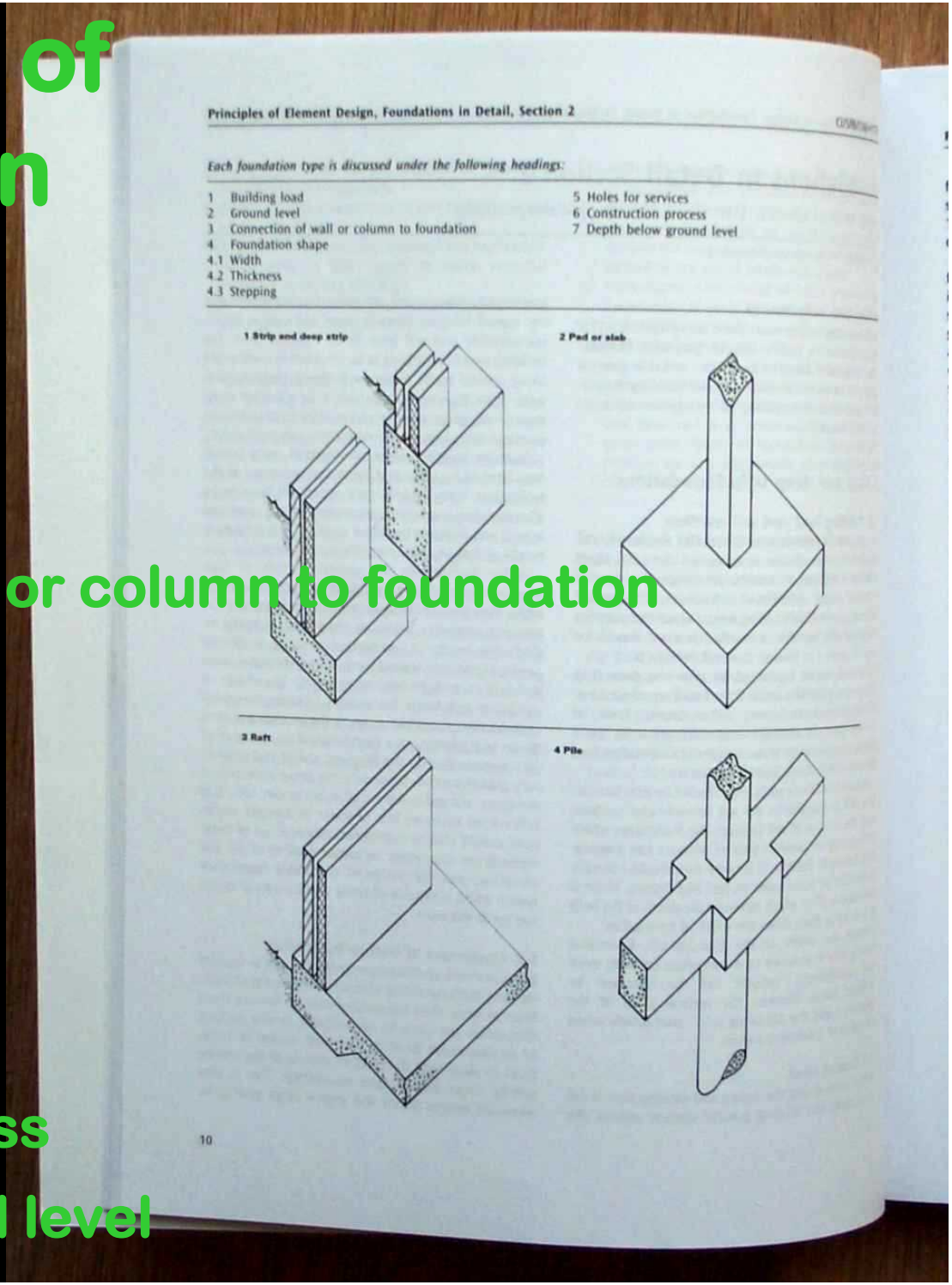
Reactions

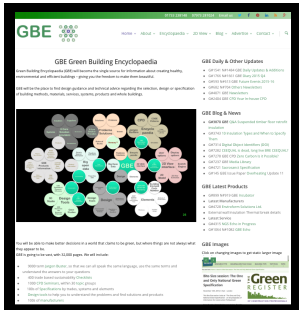
- Gravity: Support & restraint
- Wind: resilience,
- Rain: impervious hard skin, absorption and drainage, percolation, ground water table replenishment, collapsible boards
- Snow: deflection, impervious skin, absorption and drainage, sealing
- Moisture vapour: hygroscopicity, permeability, breathing, moisture mass
- Sun: moisture movement drying shrinkage, invulnerable materials, drying shrinkage
- Dirt and Dust: repulsion, exclusion, shielding, cleaning
- Backfill waste:
- Chemicals: invulnerable materials, exclusion,
- Gases: percolation, cover and control, edge ventilation, vent to roof
- Mechanical: stabilisation, toughness, edge restraint, edge protection
- Thermal: thermal insulation, thermal mass, U value, G value, cold bridge avoidance/ minimisation



Principles of Foundation Design

- Building Load
- Foundation Level
- Connections of wall or column to foundation
- Foundation shape
- Width
- Thickness
- Stepping
- Holes for Services
- Construction Process
- Depth below ground level





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Site Clearance
Site Preparation

Almost all sites

Lightweight
No foundations
Firm dry ground
is enough

Landscape & Topsoil

- Grass, plants and weeds are alive, grow, die, rot, are compressible and not ideal for carrying buildings
- They are biodegradable and compostable
- Topsoil is full of air, worms, water, seeds, insect and down to microbial life forms.
- It has taken the planet, sun, weather and life-forms millennia to create

- Its thin 0, 100 – 225 mm. thick and a scarce natural resource
- So let's scrape it off and throw it away, put it in a skip send it off to landfill
- Or stack it so high it crushes all the life and starves it of oxygen
- Or collect it in small stockpiles and reuse on site towards end of works

Subsoil

- Substantially free of living flora and fauna (plants and life forms) etc. but roots pass through it looking for water
- Subsoil is relatively stable, but is affected by moisture content fluctuations and frost
- Subsoil can be wet or dry and prone to fluctuations in level
- Subsoil is prone to mechanical disturbance by vehicles wheels and to a lesser degree tracked vehicles
- Subsoil is less compressible and ideal for carrying buildings
- Subsoil is not normally affected by sun and weather beyond surface
- Subsoil is expensive to remove (large quantities, bulky and heavy) and expensive to replace (but landfill tax is low)
- Collect it in stockpiles and reuse on site towards end of works
- Subsoil is inert as a resource to reuse or as a waste

Soil Stabilisation

- Lime stabilisation (undoable)
- Cement and Lime Stabilisation
- Cement stabilisation (permanent)
- Remove soil and replace with consolidated hardcore
- Piling mat (hardcore, temporary/perm)

SAKA

Consolidated Hardcore

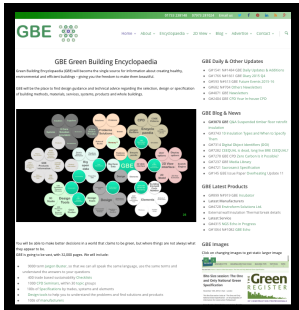
- Recycled building (if reuse is not possible)
- Inert crushed brick, stone, concrete
- 100 mm. maximum any dimension
- Relatively free of active waste (timber and plaster)
- Secondary or recycled aggregates
- Virgin aggregates (avoid if possible)
- Laid in 150 mm. layers and vibrated roller to consolidate

Brownfield sites

- Site with prior use (often includes buildings and pollution)
- May have been demolished and cleared
- May have foundations/basements and services in the ground
- May have backfill materials (polluted?)
- Long periods of site or building redundancy lends itself to occupation by nature

Backfill

- **Backfill may be:**
  - Excavation arisings: inert subsoil
  - Demolition arisings: often inert but (may be spoiled by active plaster and timber)
  - Building waste (dumped)
  - Hazardous waste (dumped)
- **It may be consolidated, remediated, built over or removed**



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Consolidation

- Stabilisation (see above)
- Dynamic consolidation (see later)
- Vibrating Roller movements
- Temporary accommodation park

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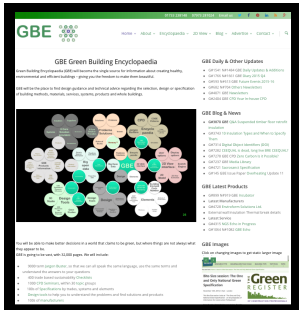
Insitu Remediation

- Mechanical cleaning, filtering, floatation,
- Chemical remediation
- Phyto-Agricultural remediation
- Bio remediation



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Build over:

- Cap the site with a building
- Ventilate any gases
  - To roof
  - To perimeter
  - Or both
  - Methane is combustible: take care
  - Radon is radio active and unhealthy

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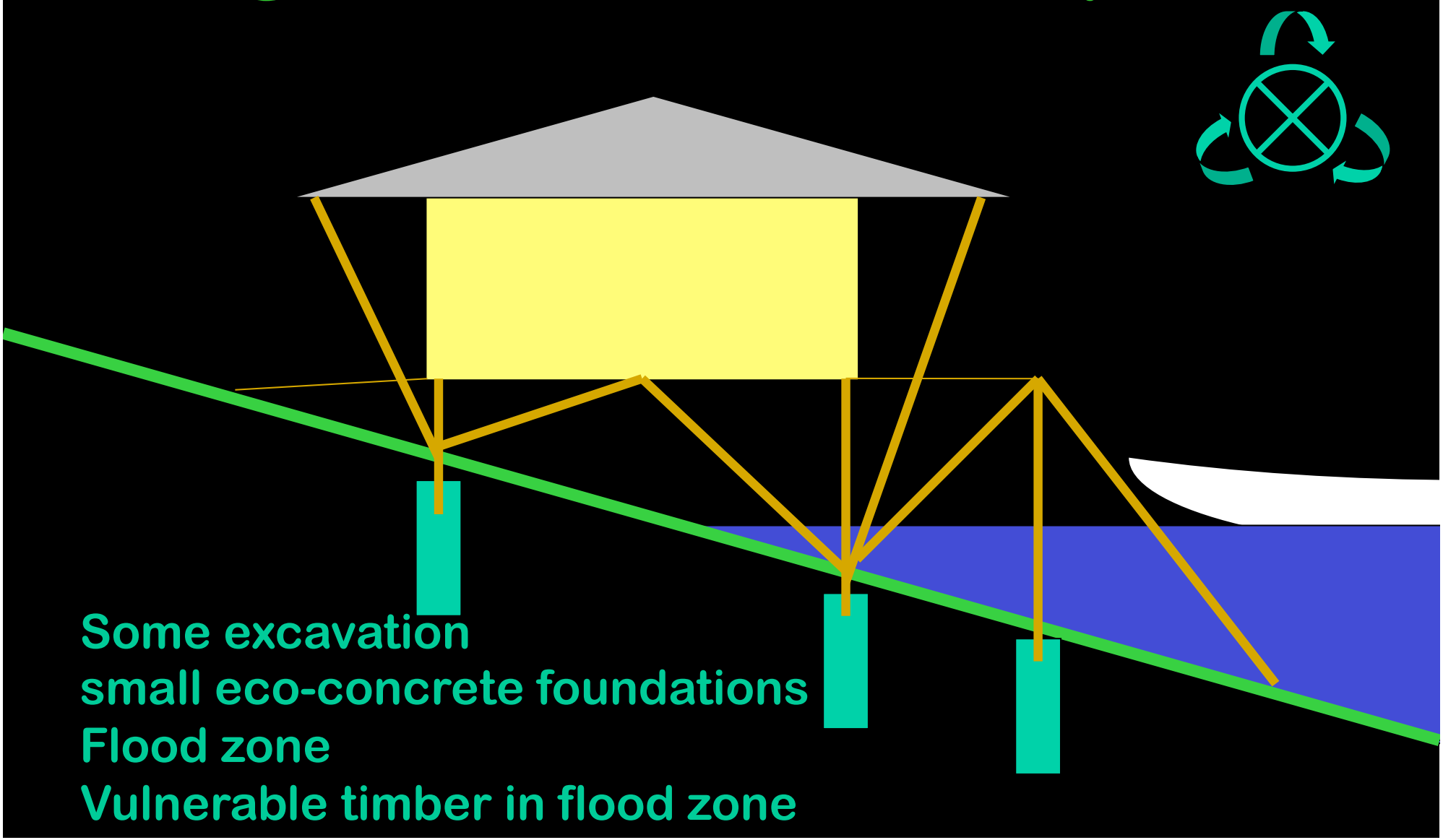
Remove Arisings to Landfill

- Reuse on site if possible
- Waste and arisings segregated on site and reused or recycled on or off site
- Arisings to transfer station to segregate for recycling and reuse
- Material Exchange
  - Earth exchange website
  - NISP National Industry Symbiosis Programme
- Subsoil to Inert landfill
- Dig and Dump (Excavate and Landfill)
- Polluted subsoil to Hazardous Landfill
- Mixed waste to normal landfill

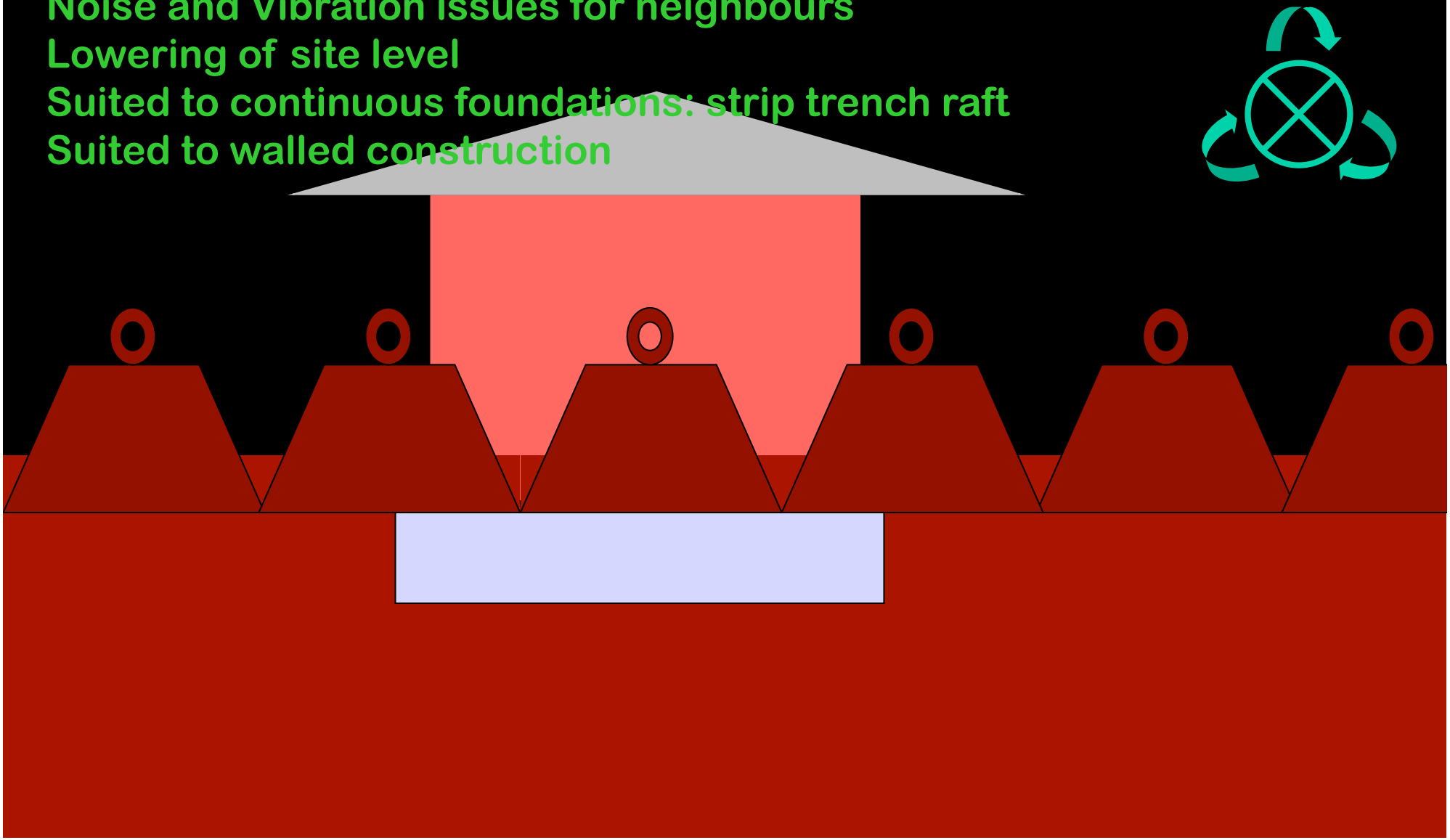
Light touch small footprint



Some excavation
small eco-concrete foundations
Flood zone
Vulnerable timber in flood zone

Dynamic Consolidation

Dynamic Consolidation of subsoil to improve load bearing capacity
Heavy touch in poor ground
Noise and Vibration issues for neighbours
Lowering of site level
Suited to continuous foundations: strip trench raft
Suited to walled construction



Dynamic Consolidation

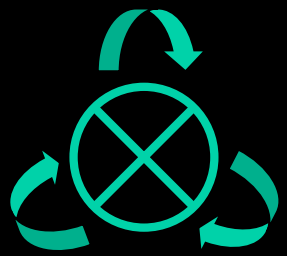
Dynamic Consolidation of subsoil to improve load bearing capacity

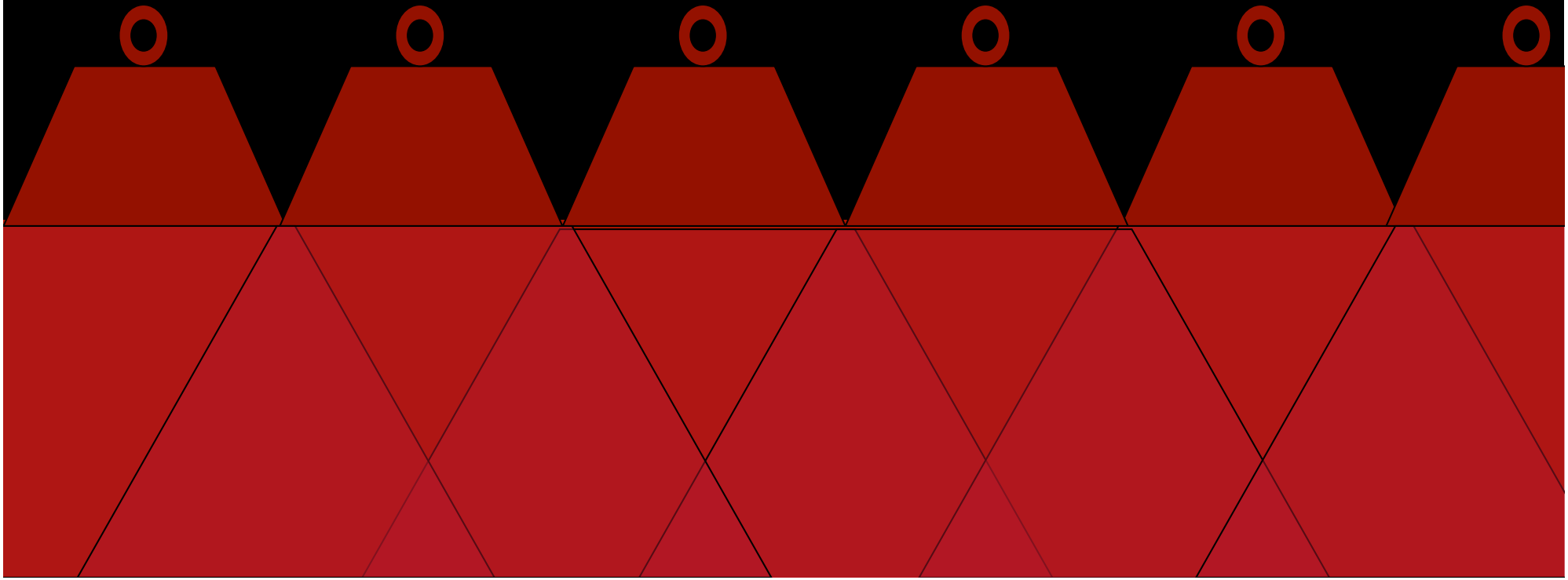
Heavy touch in poor ground

Spaced affects capacity lower down

Angle depends on soil types

Closer centres bring bearing capacity closer to surface





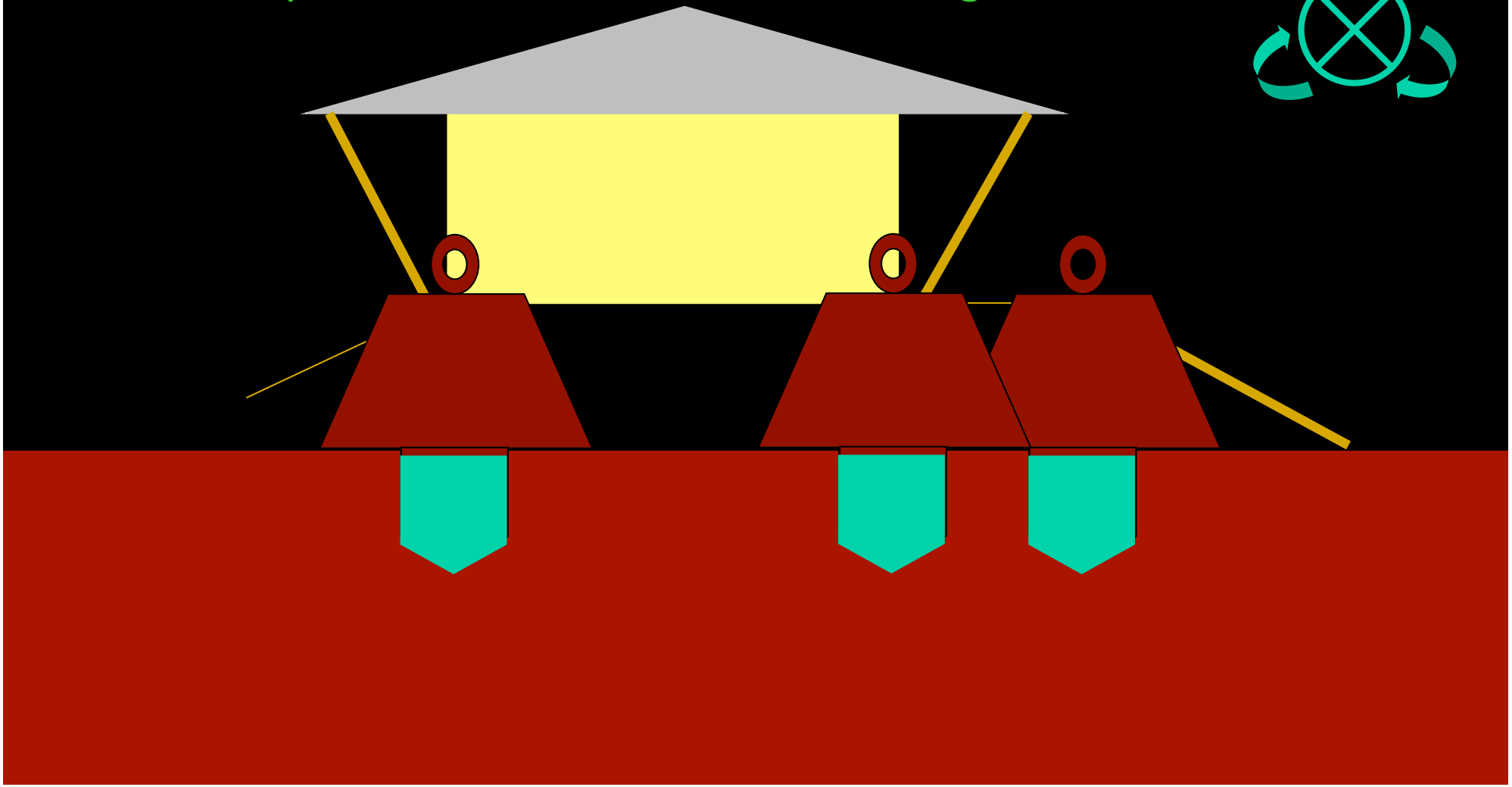
Heavy touch in poor ground

Dynamic Consolidation of subsoil to improve load bearing capacity

Noise and Vibration issues

Lowering of site level

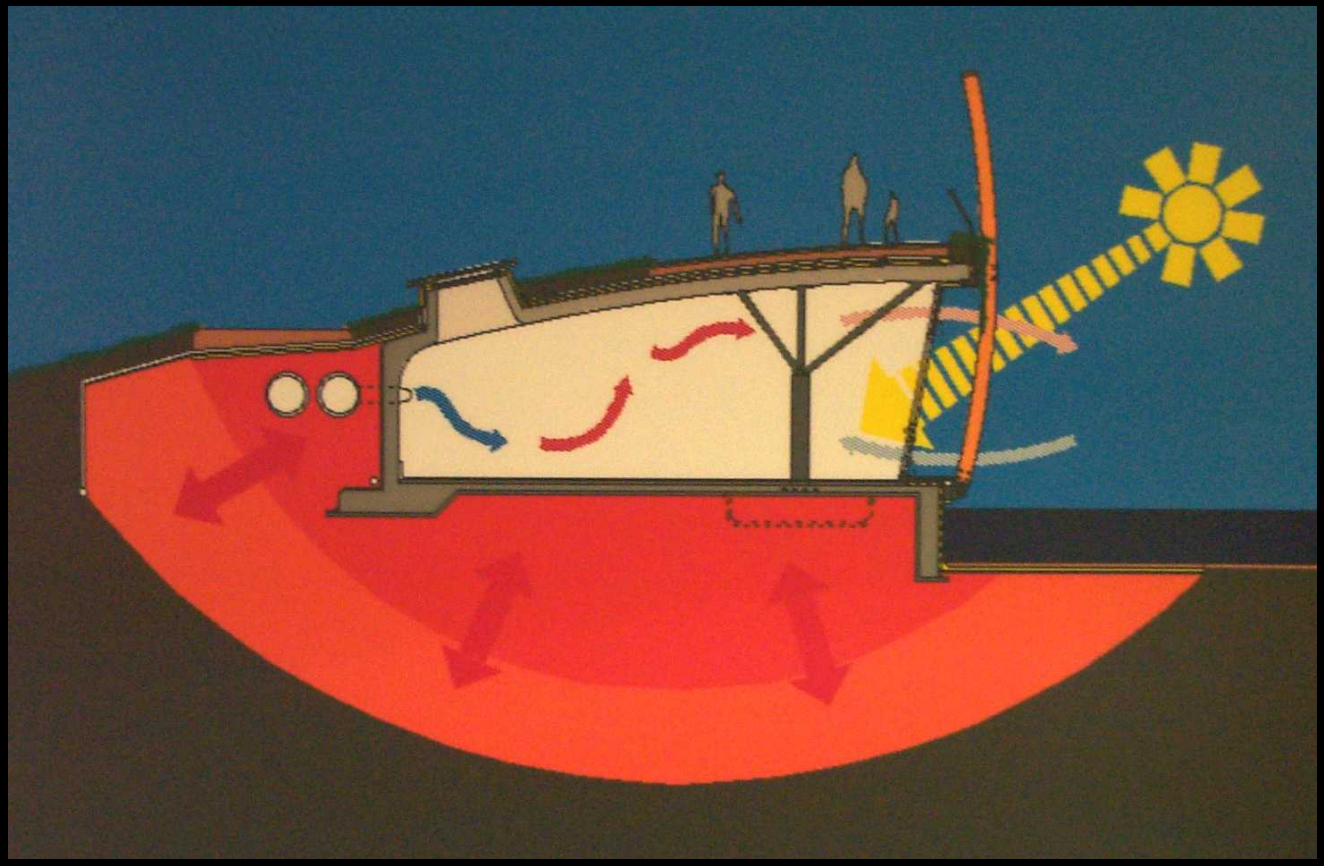
Pockets for pad foundation for framed buildings



Zero Energy Development

Mile End Road Park

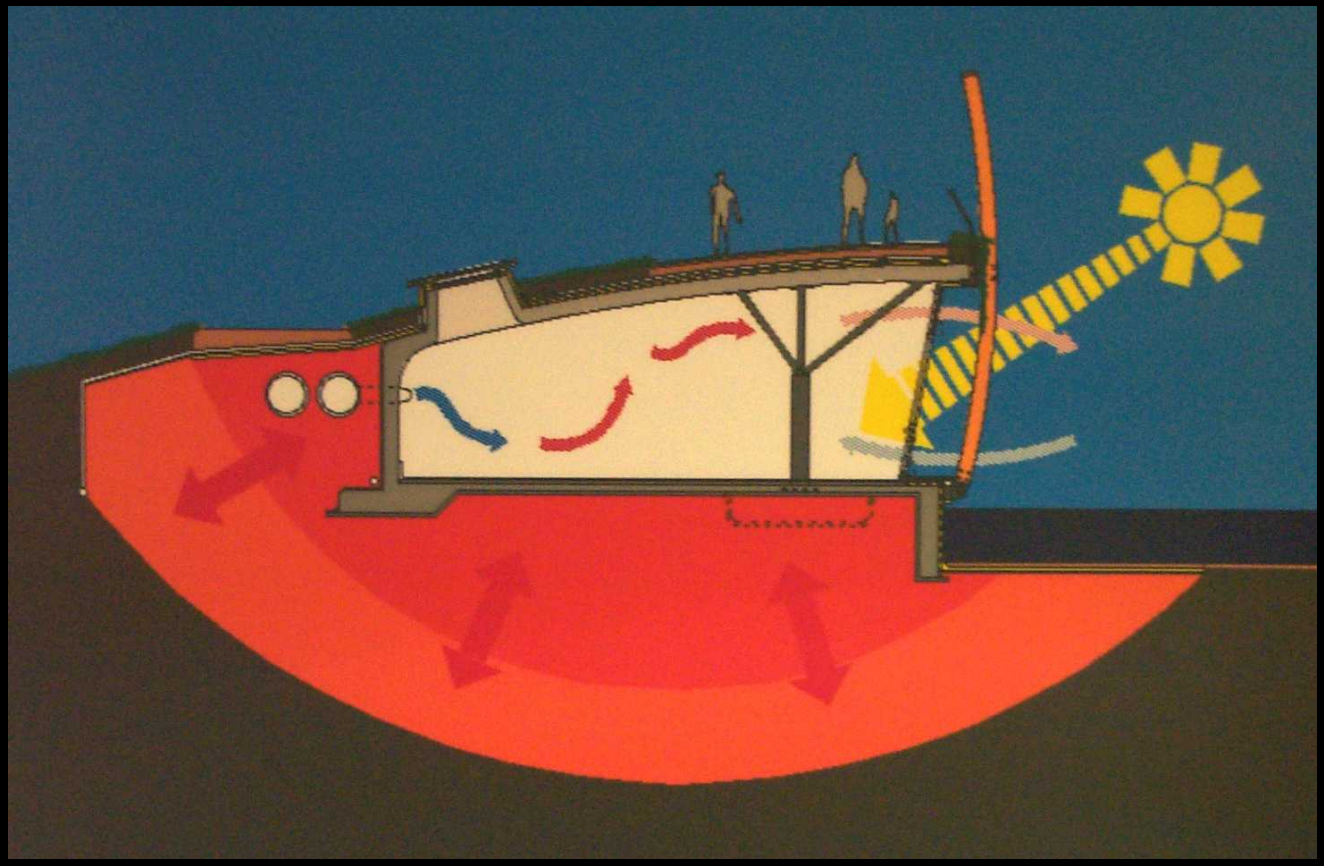
Zero Energy Development



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

Mile End Road Park, E London

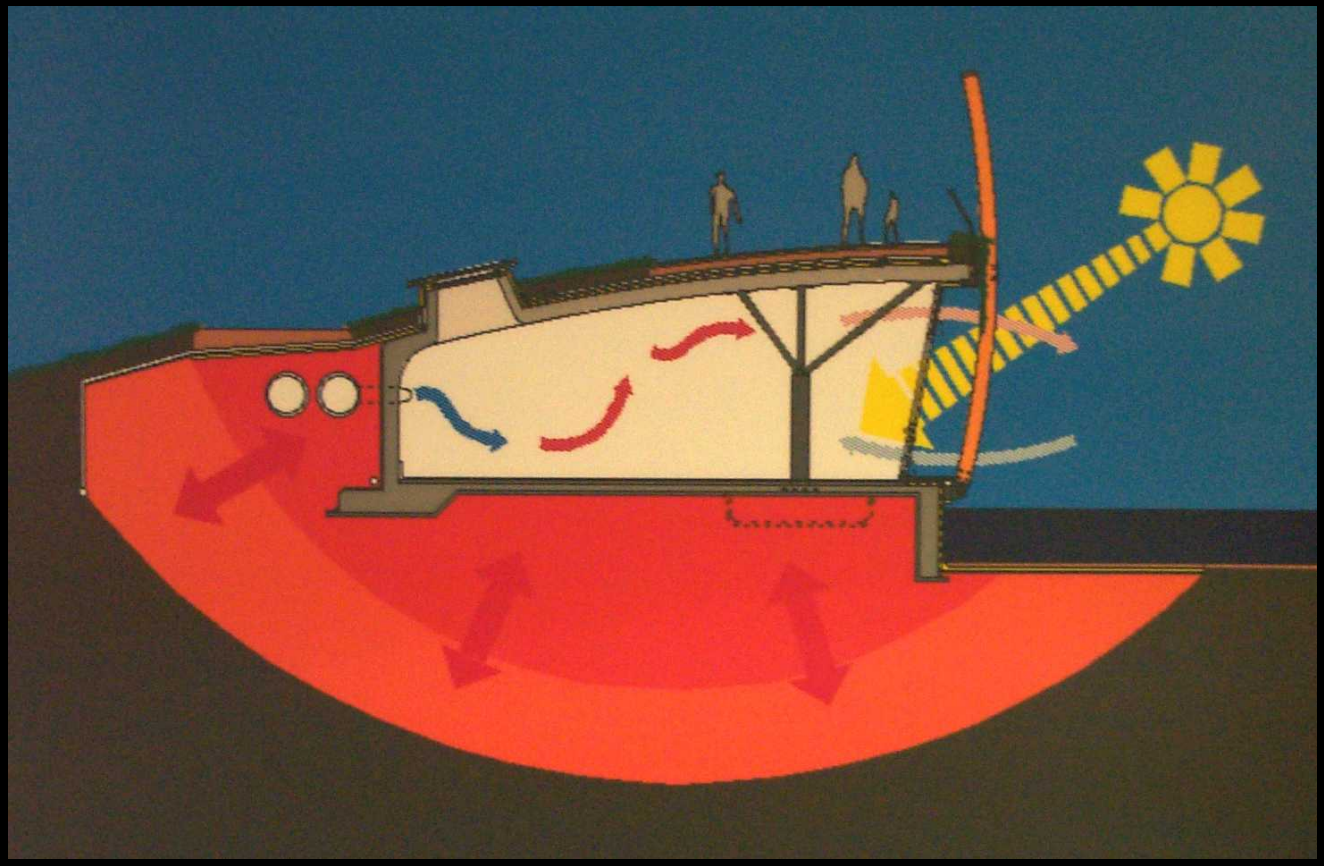
Zero Energy Development



Heat transfer in soil 1m/mth
6m insulation boards at perimeter
6 months of heat storage

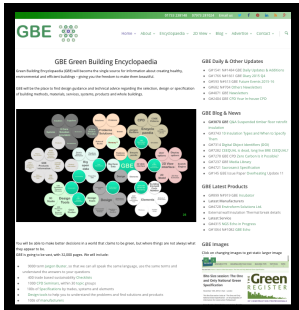
Mile End Road Park, E London

Zero Energy Development



Heat exchange into rear earth from pipes, avoids heat exchangers minimise pumps and motors

Mile End Road Park, E London



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Clay heave Collapsible board

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Clay heave

- Under floor & against foundations
- Moisture variations in clay soil causes expansion and shrinkage
- Expansion can lead to displacement
- Collapsible board accommodates expansion
- Recycled content paper honeycomb cardboard/polypropylene sheets

NGS GreenSpec - Products - Dufaylite 'Clayboard' - Void formation system - Windows Internet Explorer
http://www.greenspec.co.uk/html/product-pages/clayboard.php
File Edit View Favorites Tools Help
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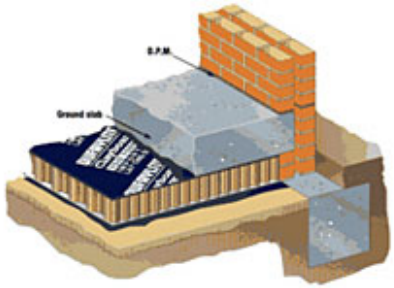
Dufaylite 'Clayboard'

Void formation system



''Clayboard' is a unique, environmentally friendly void former and foundation stabiliser developed by Dufaylite. Clayboard is a biodegradable honeycomb core set between lightweight polypropylene facings.

When dry, 'Clayboard' is strong enough to support the weight of wet concrete and steel reinforcement.

Water is introduced to the 'Clayboard' core once the concrete is set, degrading the 'Clayboard' honeycomb centre which will ultimately lead to the creation of a void. This space will accomodate clay expansion without exerting undue pressure on the structure below.

The resulting void continues to accomodate natural soil shrinkage and expansion.'

Material/s:	paper
Environmental statement:	no
BRE Ecopoints:	unrated
BRE Environmental profile:	unrated
Other environmental standards:	none
3rd party accreditation:	BBA cert 98/3528

Marketing

- ‘Clayboard’ is a unique, environmentally friendly void former and foundation stabiliser developed by Dufaylite.
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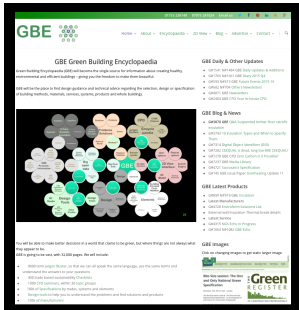

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Damp Proof Membrane

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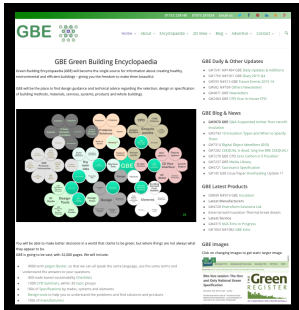
DPM

- Fabric/Clay powder/Fabric DPM
  - Uncomplicated lapping no bonding
  - No specialist applicators
  - Moisture activated
    - (sprinklered or ground water)
- Recycled content polyethylene sheet
- Many synthetic petrochemical polymeric sheets



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Damp & Gas Proof Membrane

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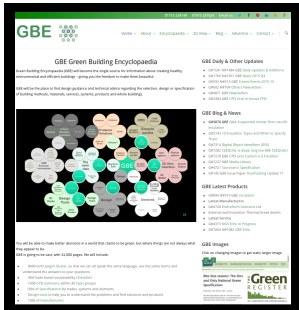
D&GPM

- Gas
  - Methane from backfill/landfill
  - Radon from granite
- Clay based not suitable
  - vapour permeable when dry
- Reinforced polyethylene sheet
- Synthetic petrochemical polymeric sheets



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Gas Venting Board

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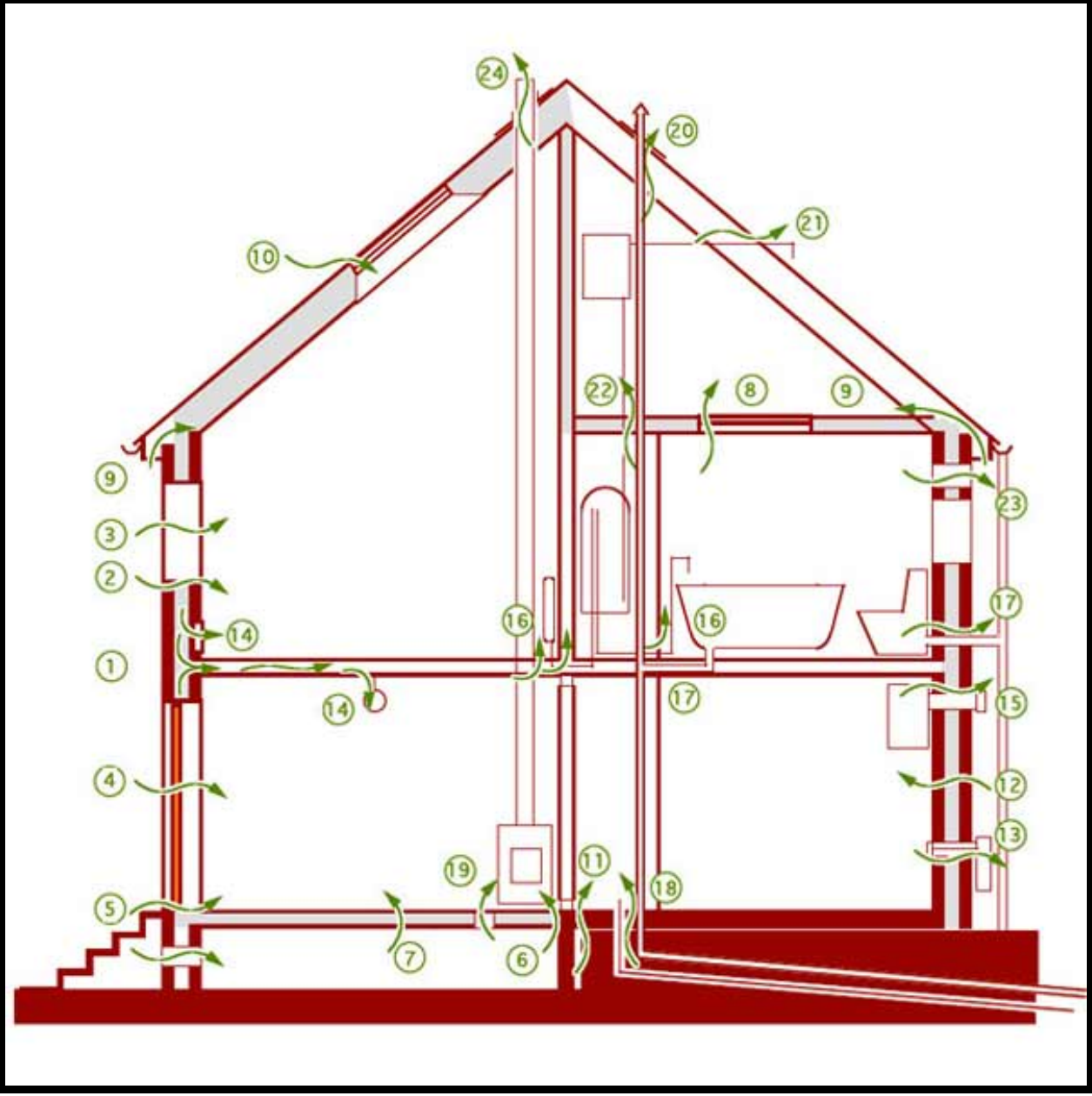
Brownfield site ventilation

- Methane from biodegrading organic waste in backfill
- Liquids and chemicals from prior use
- Petro-chemicals Hydro-carbons from prior use
- Ventilated cavity below buildings allow removal before entry into building
- Gas Proof Membrane in floors
- Often combination Damp Proof Membrane
- Cigarette smokers must take care with stubs
- Methane is combustible

Radon Ventilation

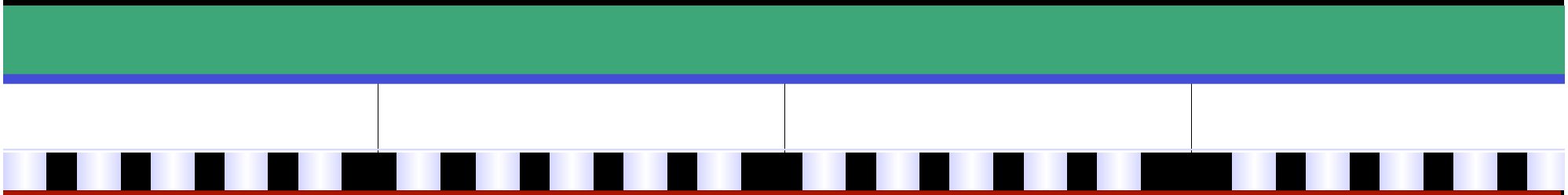
- Radio-active granite e.g. in west country
- Releases radioactivity into air
- Ventilated cavity below buildings allow removal before entry into building
- Radon Barrier: Gas Proof Membrane in floors
- Often combination Damp Proof Membrane

Leaky Buildings

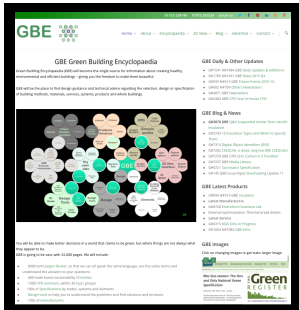


Brownfield gas ventilation boards

Insitu eco-concrete ground floor Gas/Damp Proof membrane under slab ventilation & thermal insulation board



Flat floors allows use of extensive use of modular insulation
Expanded moulded polystyrene of suitable grade
Minimises waste from off cuts
Assuming the building size or grid reflects their size
Gasses percolating up from site ventilated to perimeter
or ventilated to above roof



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Thermal Insulation Board

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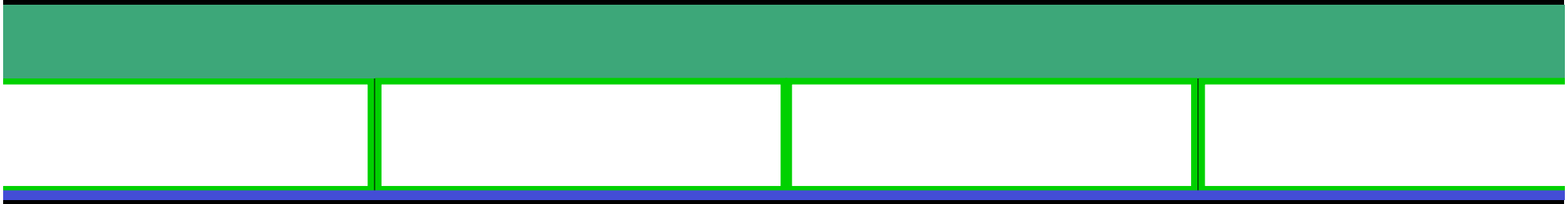
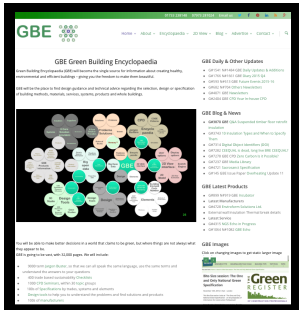
Insitu eco-concrete ground floor with under slab insulation & DPM



Flat floors allows use of extensive use of modular insulation
Minimises waste from off cuts
Assuming the building size or grid reflects their size
Materials: Expanded polystyrene or cellular glass
Performance: load-bearing, water resistant
DPM keeps insulation dry and warm
Keeps thermal mass of floor close to surface to exploit
Avoid insulating screeds
Consider thin sheet finishes or dense tile
Avoid insulation underlay and carpets



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Resource Efficiency

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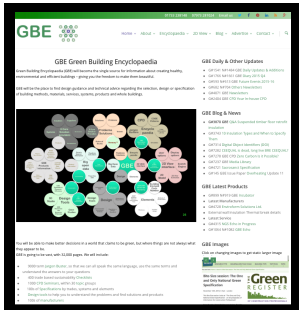

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Reuse of what you find on site

Materials arisings, opportunities to reclaim for reuse or recycling on or off site

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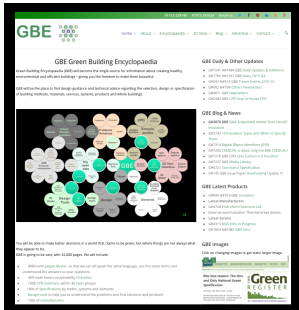

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Cycle Assessment Procedure for Eco-impacts of Materials

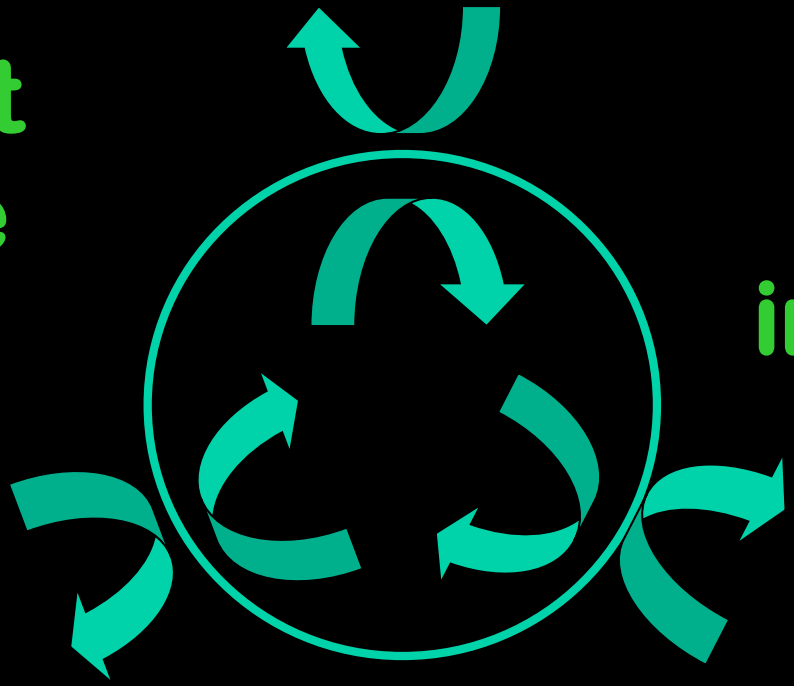
Investing in Opportunities

This project has received European Regional Development Funding through INTERREG IV B.

INTERREG IVB

Site Autonomy

No export from site



No materials imported to site

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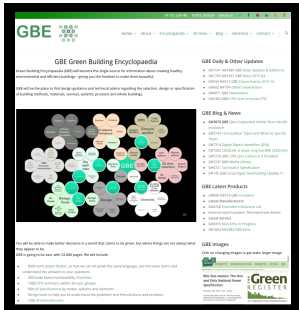

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Cut and Fill

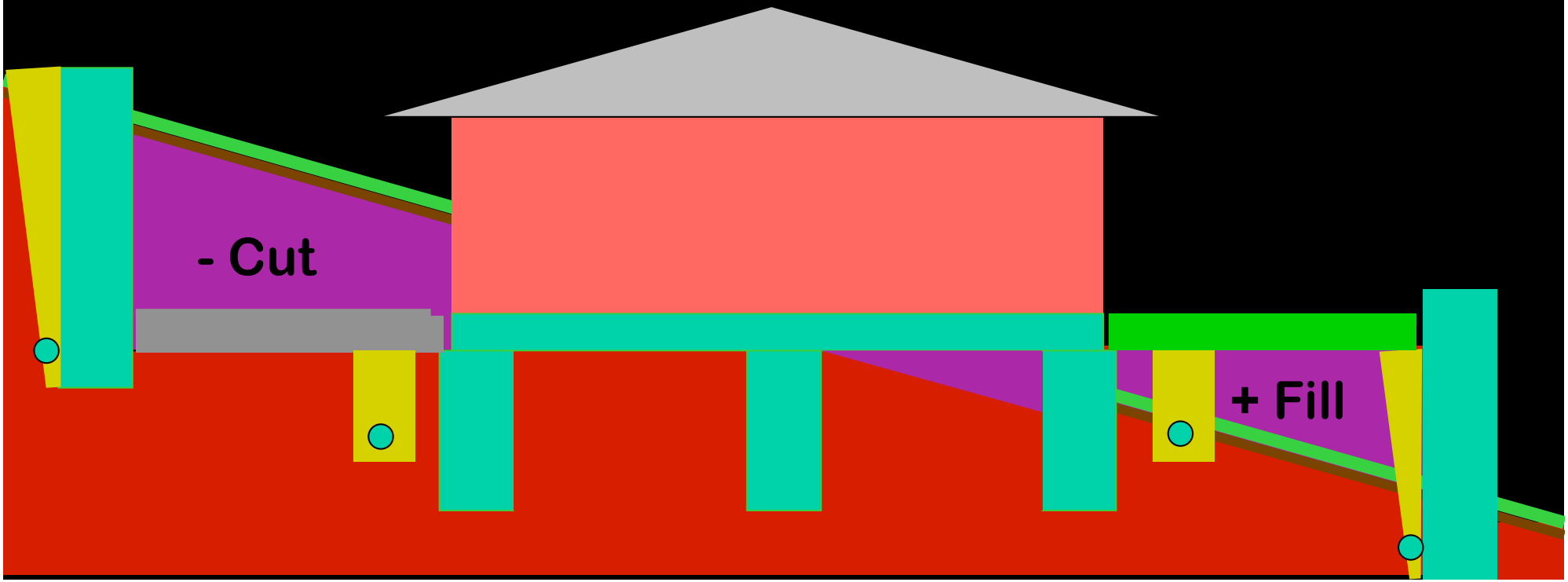
In principle a simple idea

- Cut

+ Fill

Cut and Fill

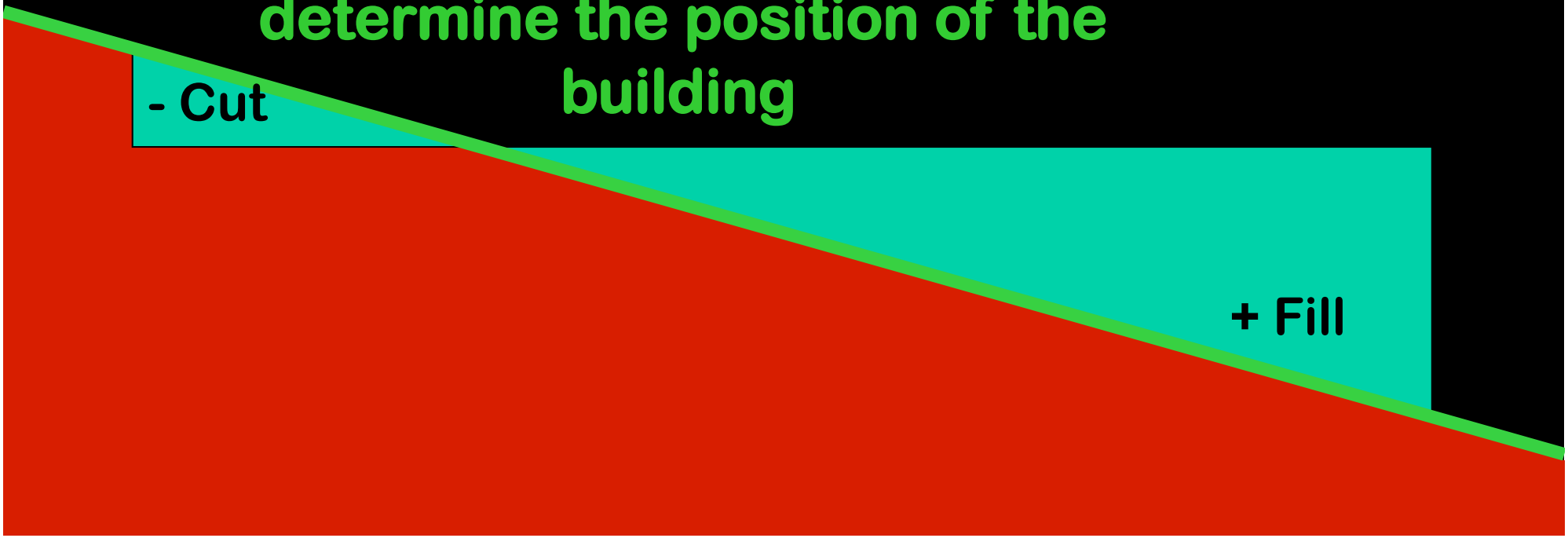
Allow for site strip, design fill size to accommodate excavated materials from:
Cut, retaining walls, land drains, foundations, floor slabs, services and drain trenches and paved areas, allow for bulking



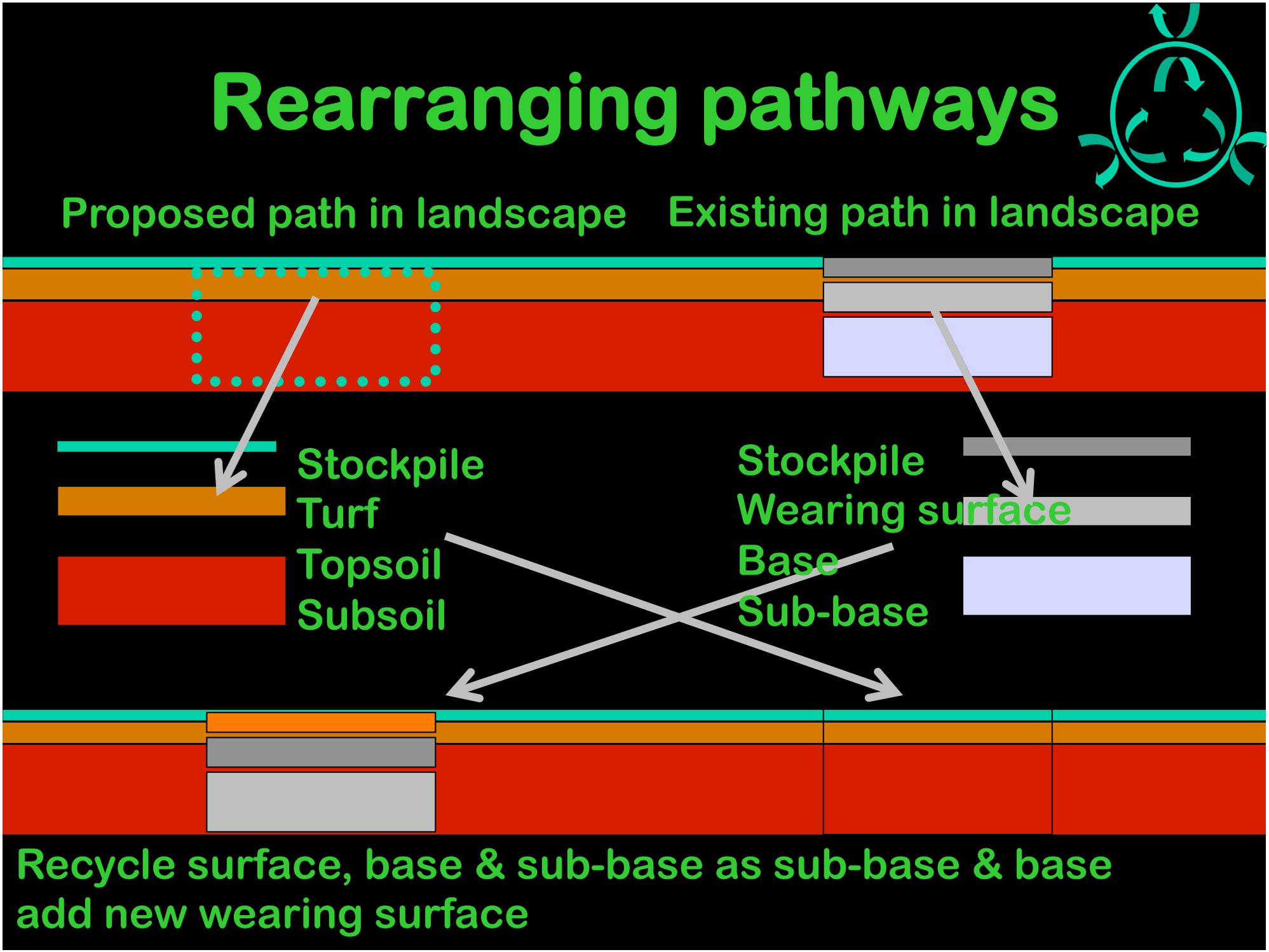
Cut and Fill

Check all your quantities first and determine the level

Or decide the level and determine the position of the building



Rearranging pathways

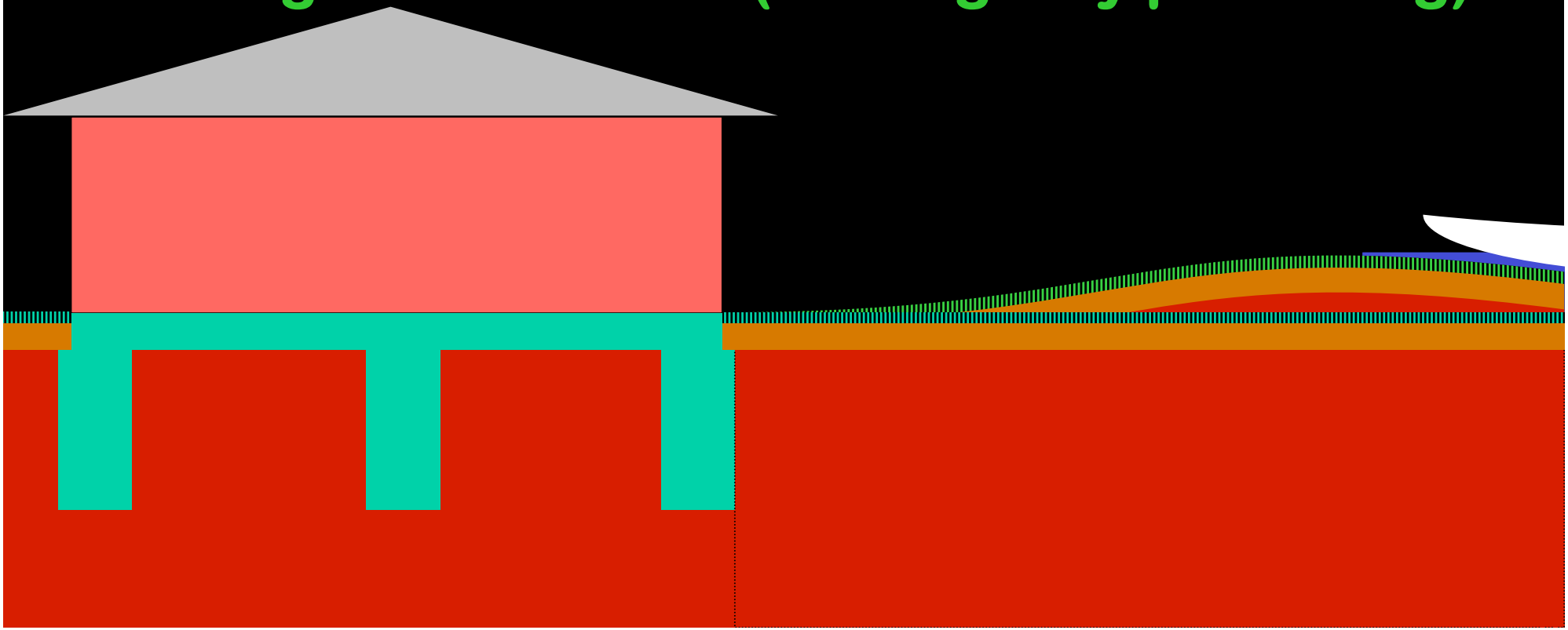


Excavation Arisings

All excavated subsoil materials to be reused on site rather than landfilled

Use it in intelligent landscape modelling

Including flood defence (Env. Agency permitting)



Environment Agency

- Nick-name: Anti-recycling league
- Government Agency:
- Police: Environment , Waterways and Water Bodies, Landfill, Pollution, Leaks and emissions, Fly-tipping, Site Waste, water use and abuse
- Right to close sites if abusing the law

On-site Best Practice:
Initial Site Strip: Landscape Waste
Spread Seeds on topsoil to discourage weeds
Cover topsoil with turf
Topsoil Stockpile
Collect Seeds
Grass Compost
Site Strip Area
Mix Green Waste with grass cuttings compost
Leaf Compost
Bush & Tree Trimmings
Turf
Sub-soil
Hardcore

On-site Best Practice: Reuse of Green waste in Landscape

Use found materials

Boulders, wild turf roof, gravel margin gutter, rubble wall

Rubble Walls

Random sizes, natural look, lime mortar, sheltering roof

Pembrokeshire
traditional
Hedge Bank

Rubble
Soil
Turf
Rainwater

Back to nature
very rapidly

Pembrokeshire hedge bank

Random rubble & slate outer leaves, wild turf mortar, subsoil cavity fill, topsoil & wild turf/hedge plants on top, crevices for nature, rain rejuvenates in weeks

Brown Roofs

Creekside Visitors Centre Deptford London

Brown Roofs

Shifting shingle - plants of shingle beaches
Comprising ridges of pebbles that shift during storms and at high tides, and exposed to regular inundation
of salt water, the shingle beach is a difficult place for plants to live. Many of the species that colonise it
are annuals that complete their lifecycle within a year. These include yellow vetch (Vicia lutea) and wild carrot
(Daucus carota). Other species are short-lived perennials such as horned poppy (Glaucium flavum) and sea
pea (Lathyrus japonicus). Sea kale (Crambe maritima) provides a glorious froth of white flowers in
becoming rarer

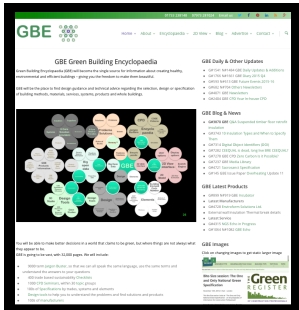
Brownfield Landscape

- 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.

Topsoil & Subsoil Stockpile on site

Excavation Arisings

- 5 basements, 2 football pitches per floor
- 1 excavator scoop/minute for 4 years
- Subsoil to Lee Valley
- Piled foundations
- Secant Pile Perimeter Wall and cavity gutters
- Anchored into ground below St Pancras and housing site adjacent and below underground tunnels all around
- 500 year design life
- Buoyant Basement as ground water rises
- Pressure relief wells and pumps
- Extra concrete cover to reinforcement (150 mm.)



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