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**CAP'EM**

Cycle Assessment Procedure for Eco-impacts of Materials



# (16) Foundations

**CI/SfB: (16) Foundations:**

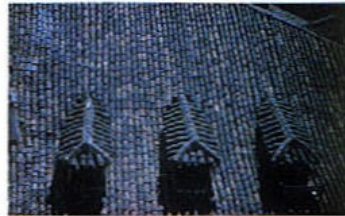
**For Framed & Distributed Loads**

# LSBU Tech & Env 2 Lecture

- **Domestic, Small & Medium size buildings**
- **Construction methods, materials, services and systems**
- **Foundations**
- **intake and disposal services**

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 (Arch) (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** BA (Hons) BA (Dist) (Hons) BA, 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.



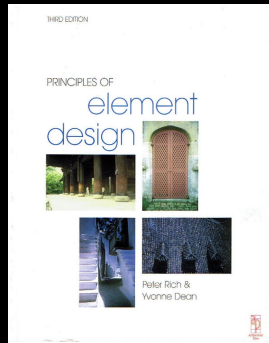
**Architectural Press**

An imprint of Butterworth-Heinemann  
<http://www.bh.com>

ISBN 0-7506-3113-9



9 780750 631136



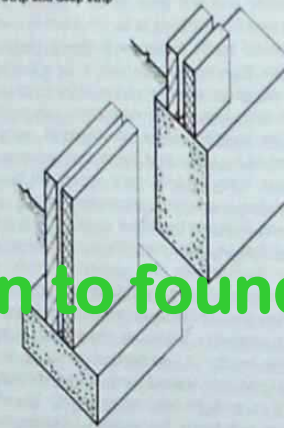
# Principles of Foundation Design

- 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

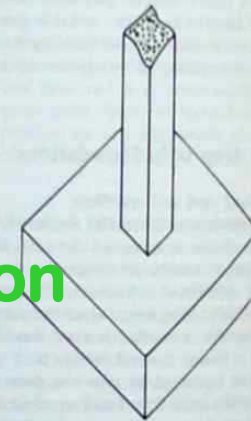
Each foundation type is discussed under the following headings:

- 1 Building load
- 2 Ground level
- 3 Connection of wall or column to foundation
- 4 Foundation shape
  - 4.1 Width
  - 4.2 Thickness
  - 4.3 Stepping
- 5 Holes for services
- 6 Construction process
- 7 Depth below ground level

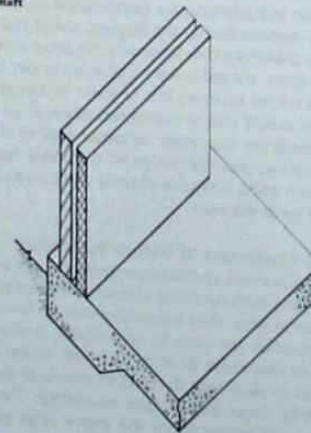
1 Strip and deep strip



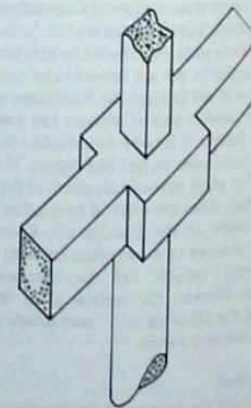
2 Pad or slab



3 Raft



4 Pile



# 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**



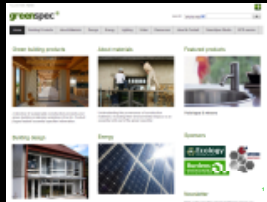
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# Site Clearance Site Preparation

Almost all sites



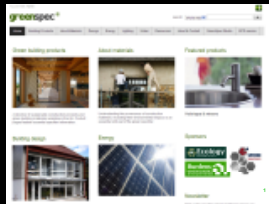
# (11) Ground

CI/SfB (11) Ground

Profile, Composition, preparation, water

Another GBS CPD/Lecture file to download  
and [www.greenbuildingencyclopaedia.uk](http://www.greenbuildingencyclopaedia.uk)

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# Site Remediation

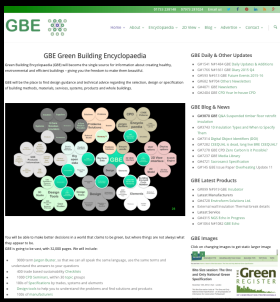
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and [www.greenbuildingencyclopaedia.uk](http://www.greenbuildingencyclopaedia.uk)

Lightweight  
No foundations  
Firm dry ground  
is enough



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# Timber Frame Foundations: Pads to Piles

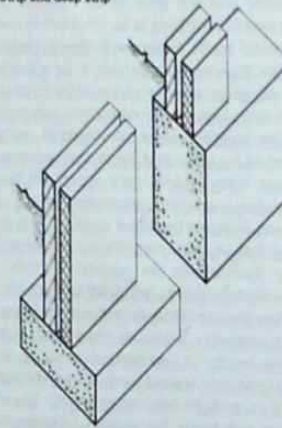
# Framed building foundations

- Pad Foundation
- Pile Foundation
- Ground Beams

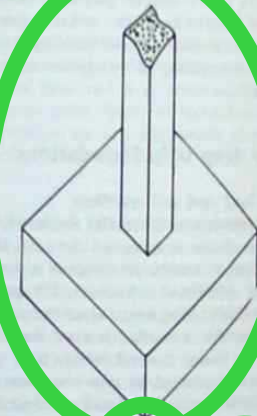
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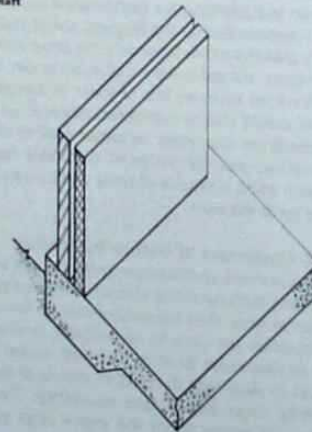
1 Strip and deep strip



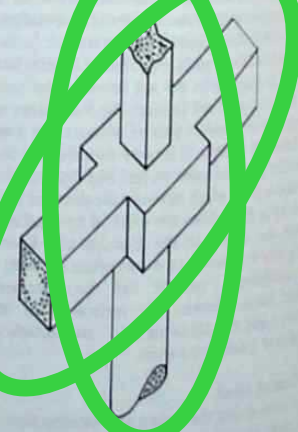
2 Pad or slab



3 Raft



4 Pile



# Modular framed designs

- Walter Segal Method
- Simple low impact foundations

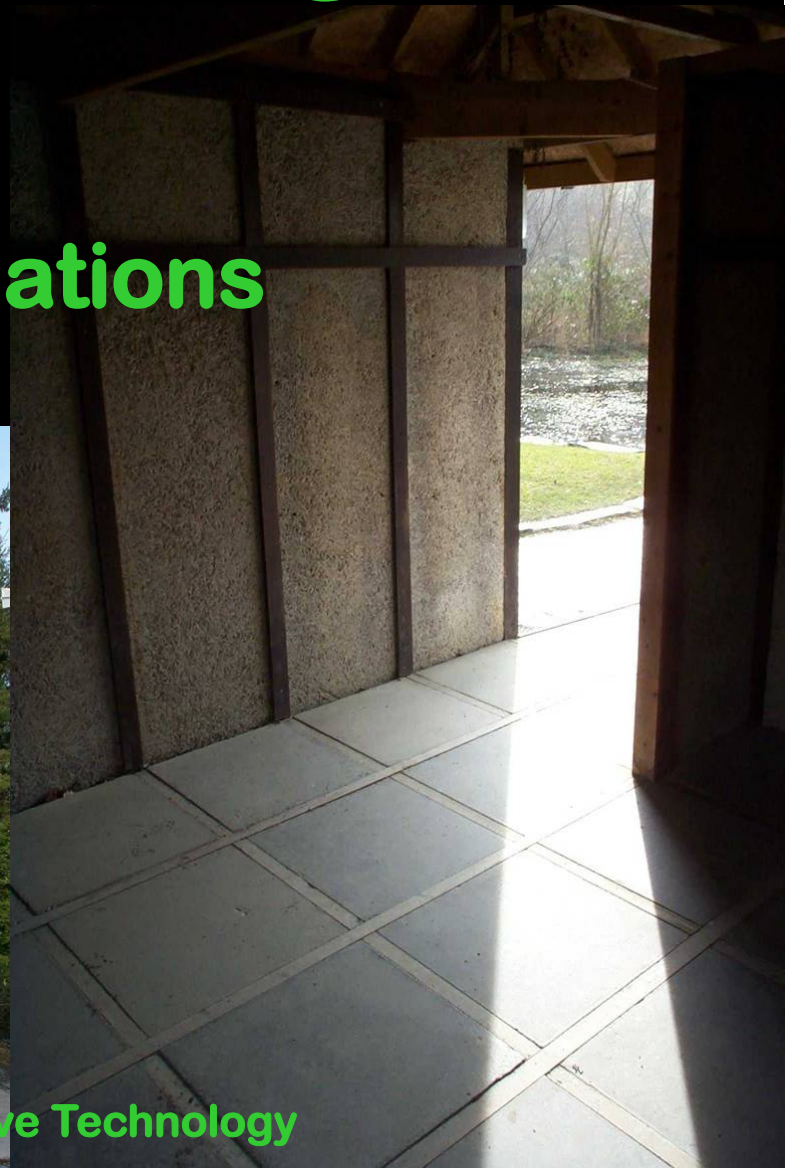
Robin Hillier Diggers  
Self-build Brighton



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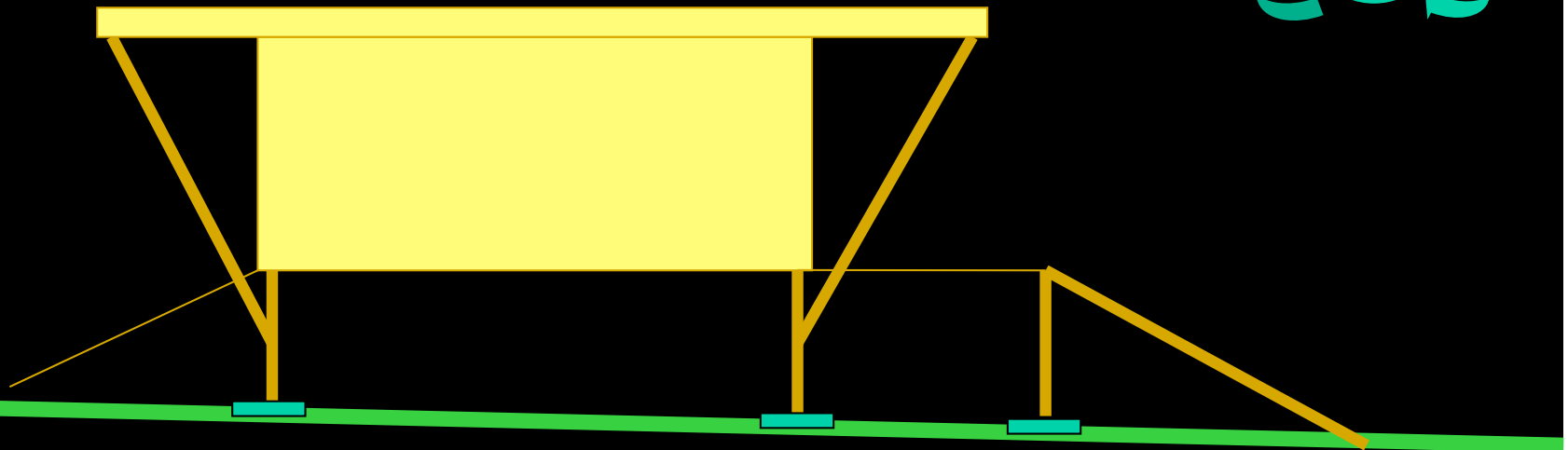


CAT Centre for Alternative Technology



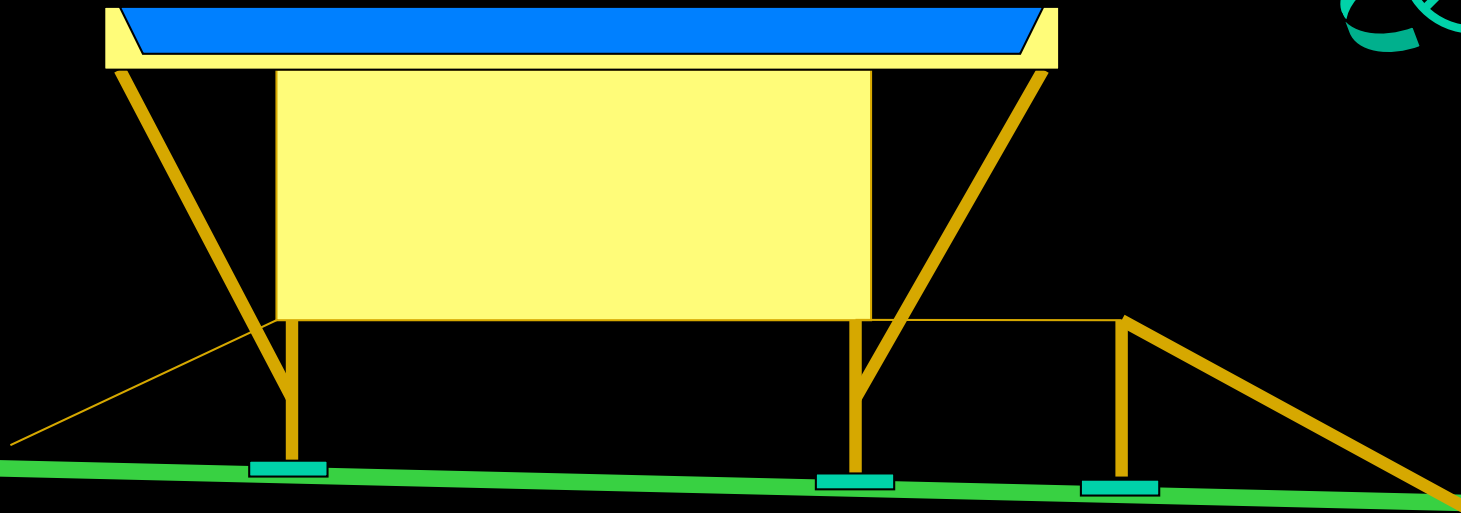
# Light touch small footprint

-ve pressure  
risk of wind uplift



No excavation  
Paving slab foundations  
Flat roof risk of wind uplift

# Light touch small footprint



No excavation

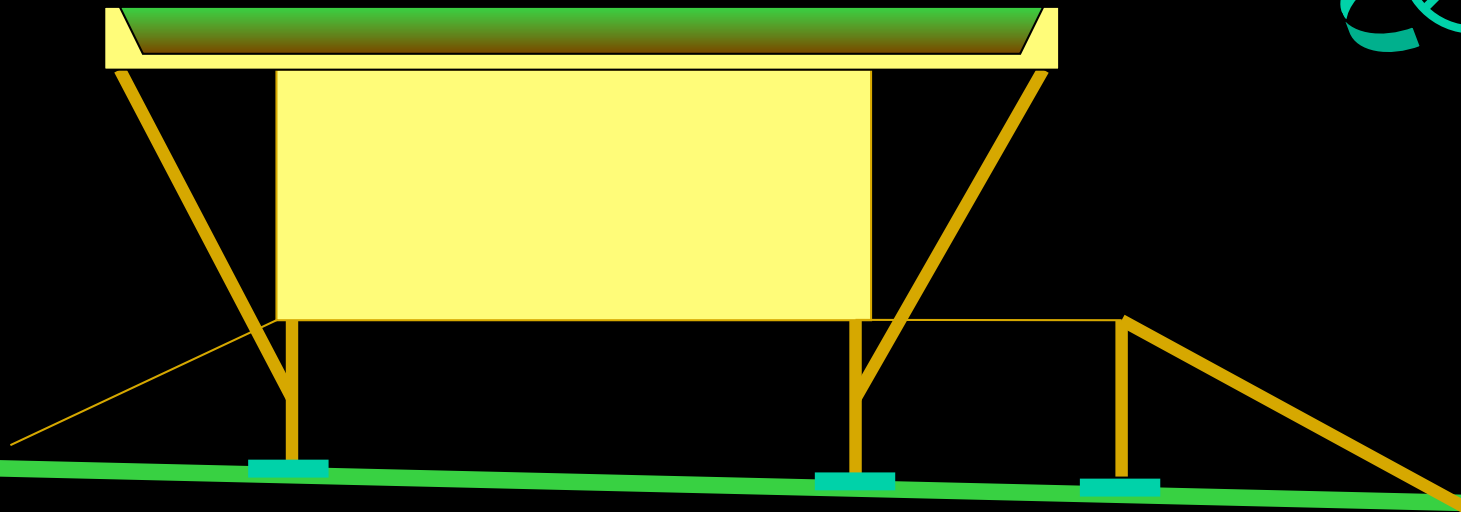
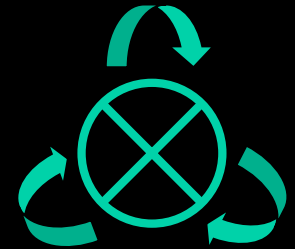
Paving slab foundations

Add water for ballast against wind uplift (top up in summer)

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Thermal Mass, solar protection and evaporation cooling

# Light touch small footprint



No excavation

Paving slab foundations

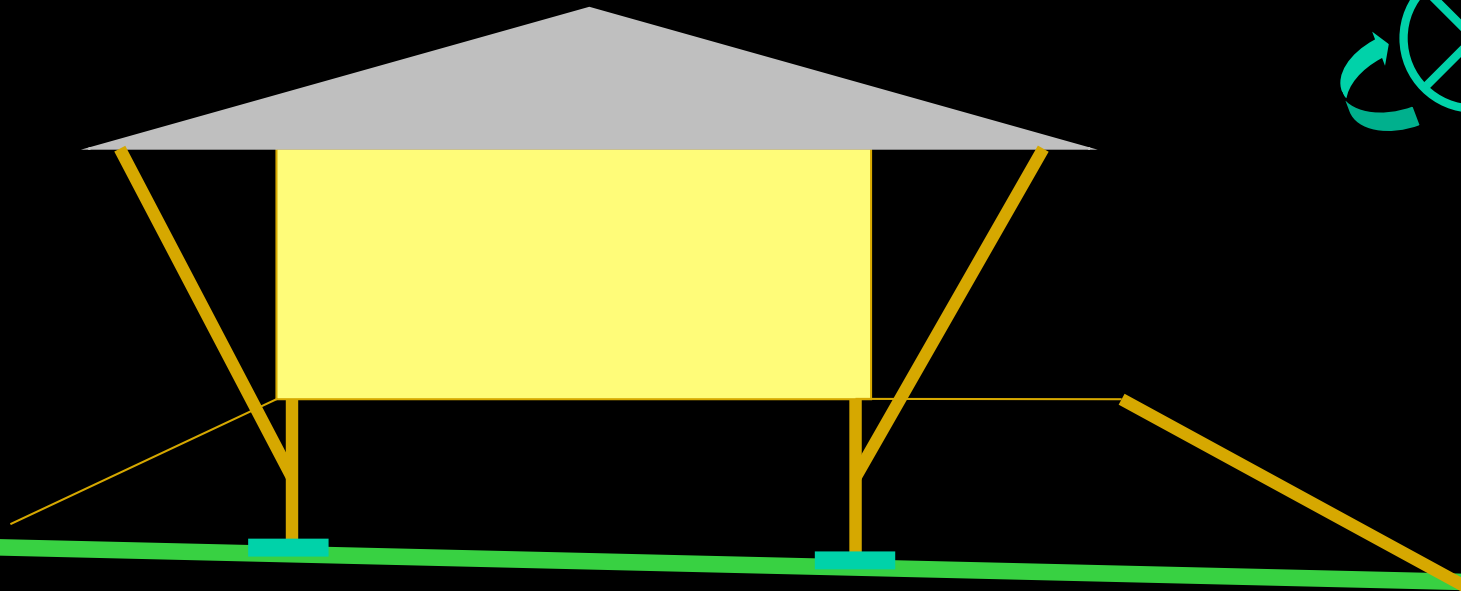
Add living roofs for ballast against wind uplift

Thermal mass, solar protection and acoustic insulation

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# Storage of spares for maintenance



- Space under building for storage
- Space for flood water
- Space for nature
- Space for children's play

# Design for simple foundations

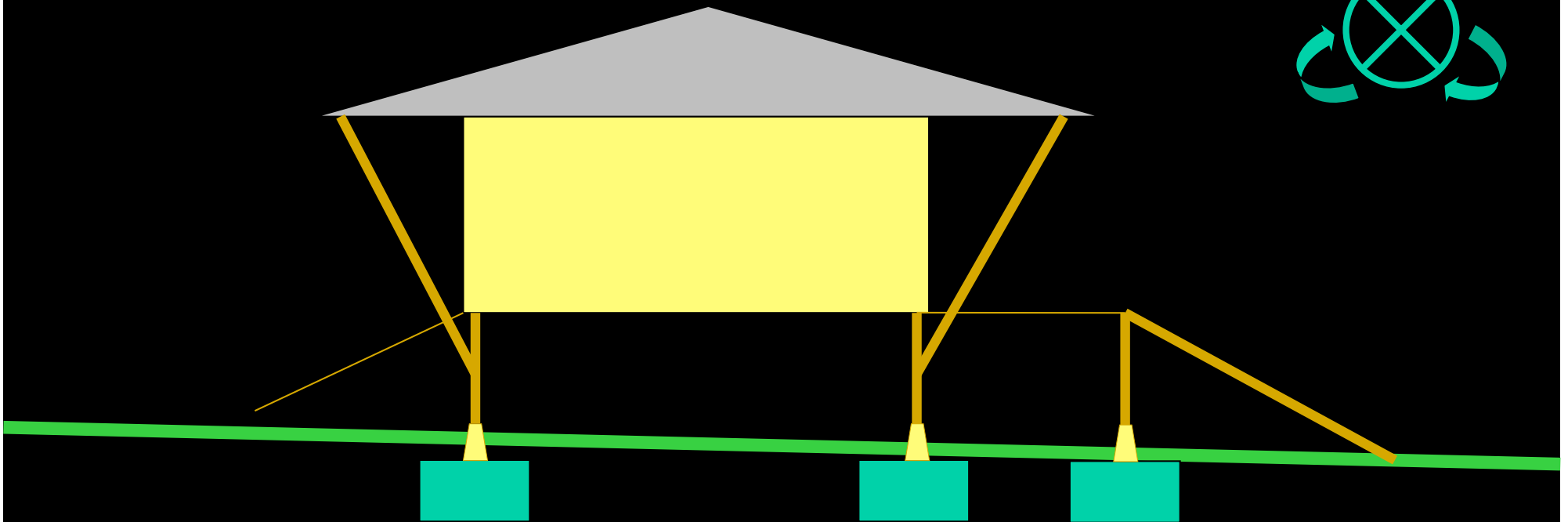
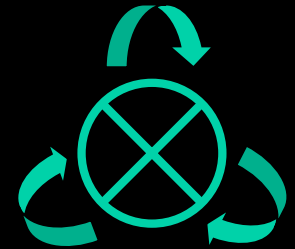
- Post & frame
- Location fixing
- Weight keeps in place
- Wind loads push down



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# Light touch bigger footprint



Shallow excavation

Pad foundations

11/06/16 ~~16~~ve wind pressure on roof



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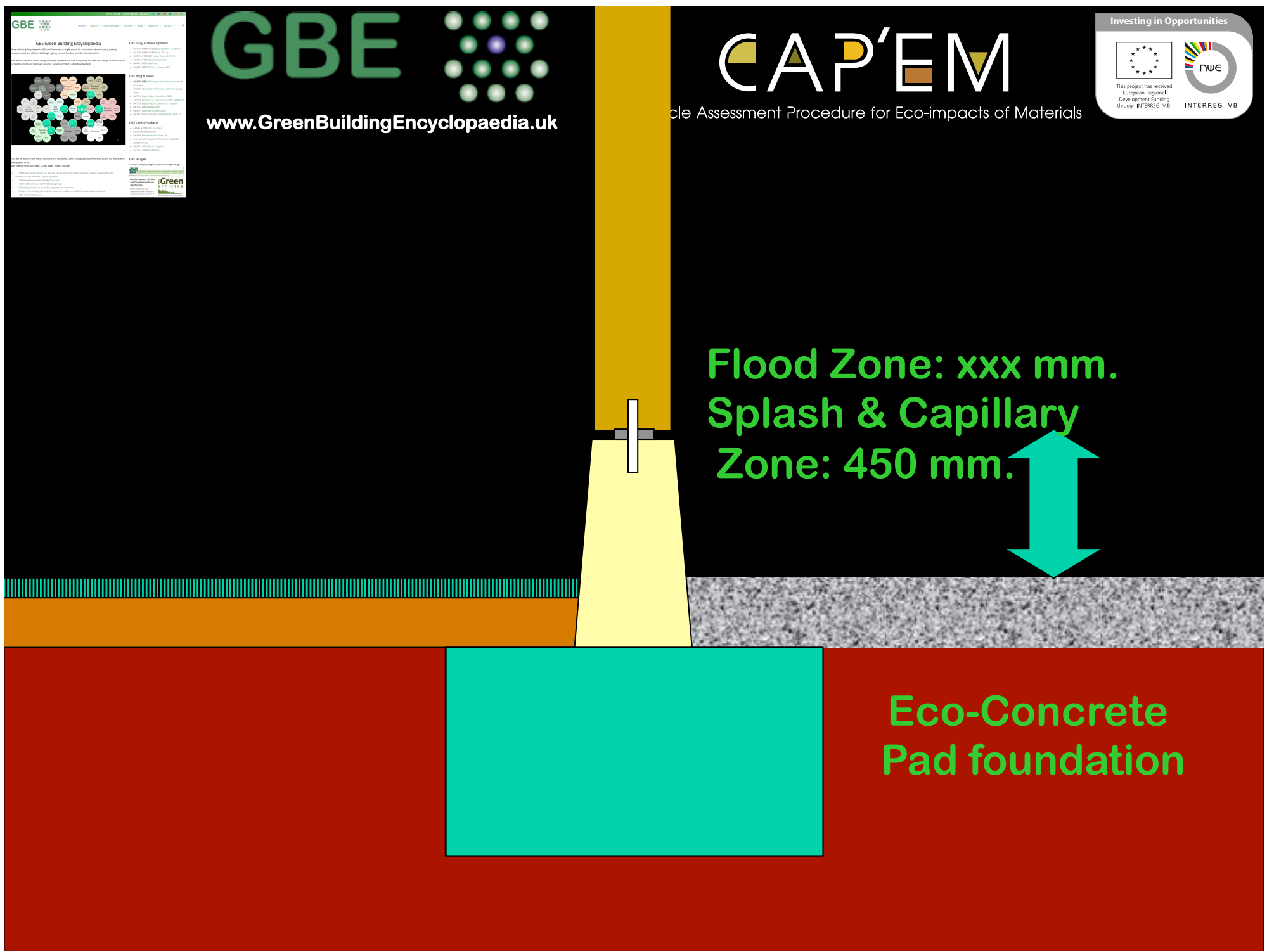
Circle Assessment Procedure for Eco-impacts of Materials



Flood Zone: xxx mm.  
Splash & Capillary  
Zone: 450 mm.



Eco-Concrete  
Pad foundation





# Roundwood: trees from site

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No ground contact, flood zone, anti-splash height, air movement, place for nature

Gas service ventilation zone before entry, services suspension zone

# EcoConcrete

- **Reduced OPC Ordinary Portland Cement content (reduced CO<sup>2</sup> 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.)

# Limecrete

- **Replaces OPC Ordinary Portland Cement content (reduced CO<sup>2</sup> production)**
  - Lime (lower CO<sup>2</sup>, recyclable, slow set, avoid frost)
- **Reduced Primary or Virgin Aggregates (sand and gravel)**
  - Secondary aggregates (waste or by-product)
  - Recycled aggregates
  - Recycled concrete aggregates
  - Recycled other materials
- **Mains drinking water supply**
- **Use permanent formwork in ground**

# Hemp-Lime crete

- **Replaces OPC Ordinary Portland Cement content**
  - Lime
    - lower CO<sup>2</sup>, recyclable, slow set, avoid frost
- **Replaces Primary or Virgin Aggregates (sand and gravel)**
  - Plant based aggregates
    - Carbon sequestration, Carbon negative
- **Mains drinking water supply**
- **Not suitable for foundations**
  - May be suitable for ground floors

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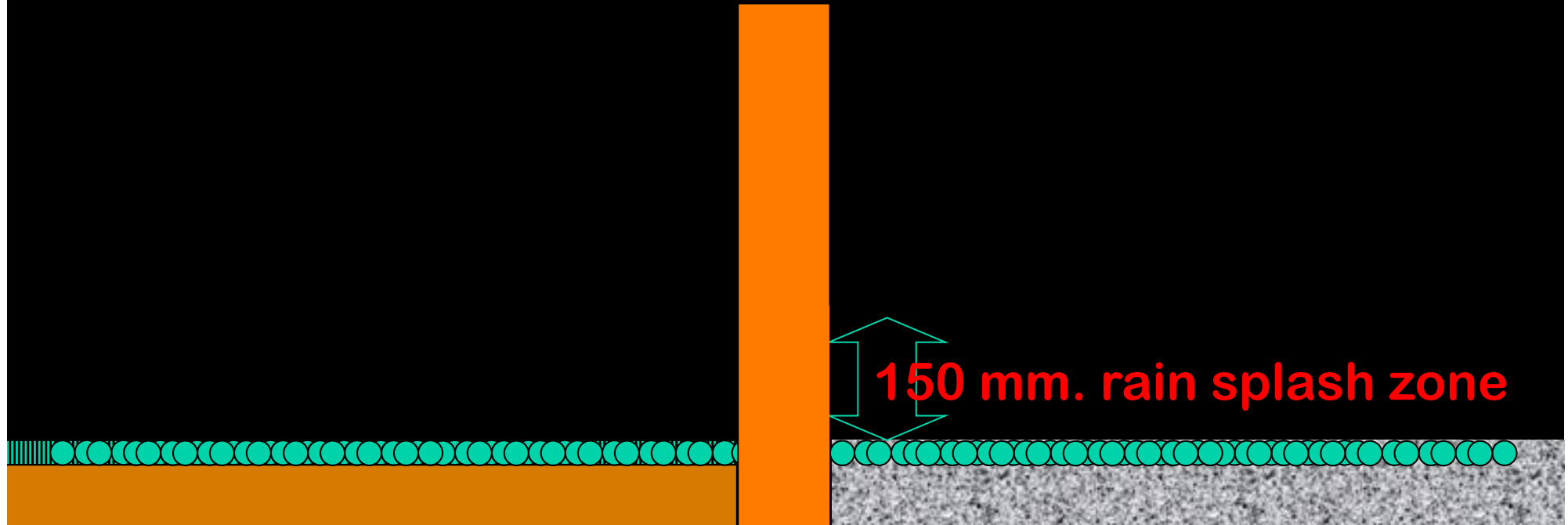
Cycle Assessment Procedure for Eco-impacts of Materials

Investing in Opportunities

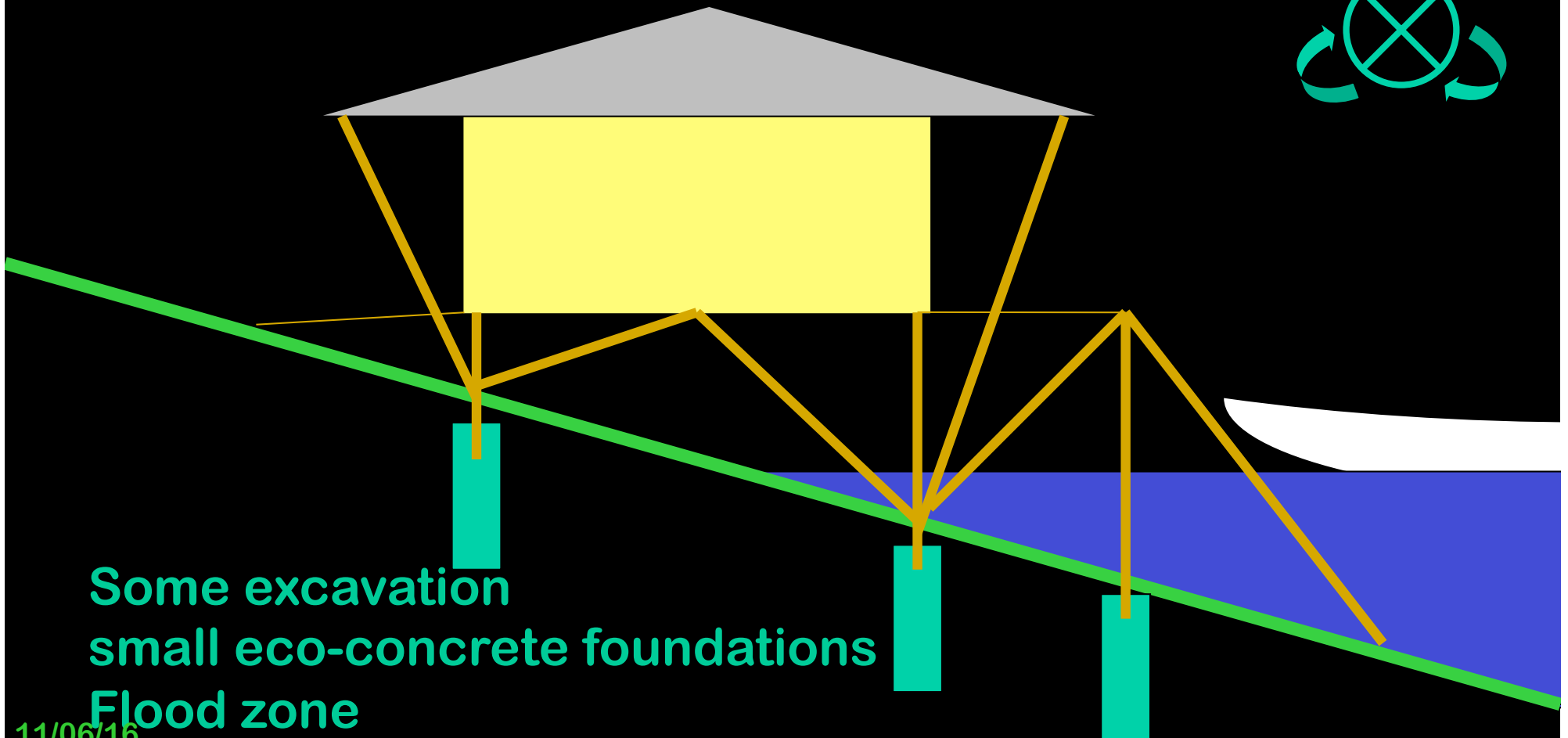
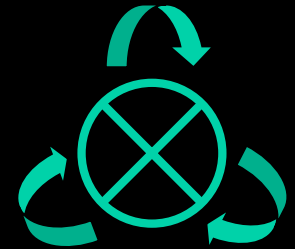
This project has received European Regional Development Funding through INTERREG IV-B.

INTERREG IV-B

# Rain Splash



# Light touch small footprint



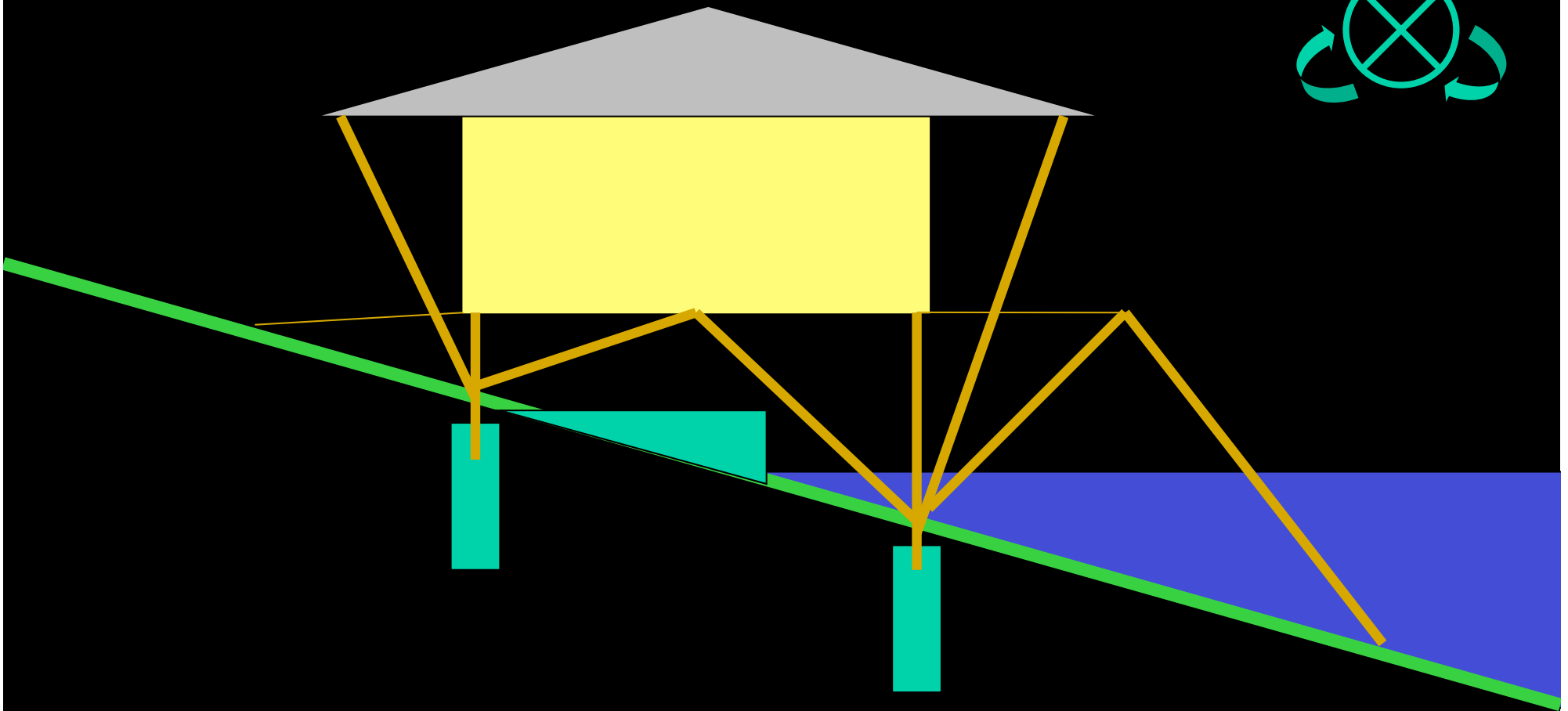
Some excavation  
small eco-concrete foundations

Flood zone

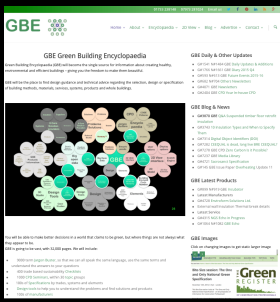
Vulnerable timber in flood zone

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# Storage of spares for maintenance and a light touch



13/06/16 Spaces of services and storage above flood zone



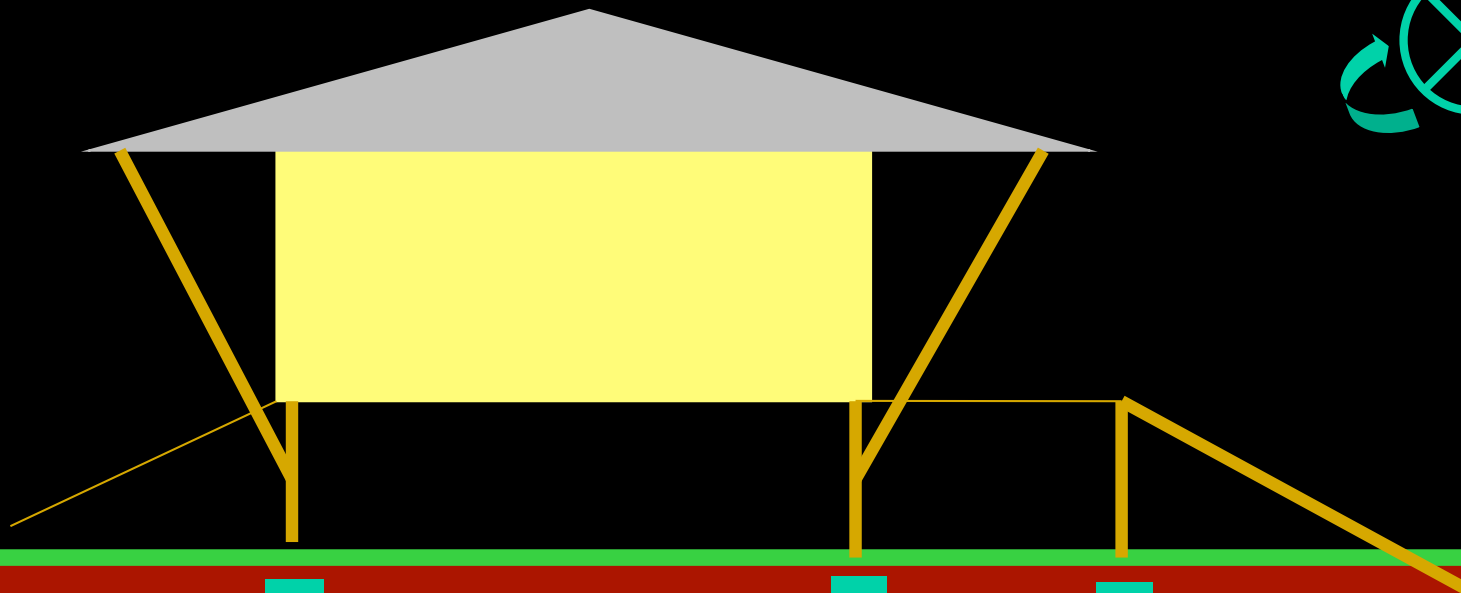
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# Driven Piled Foundations Minimise Arisings

# Not so light touch in poor ground

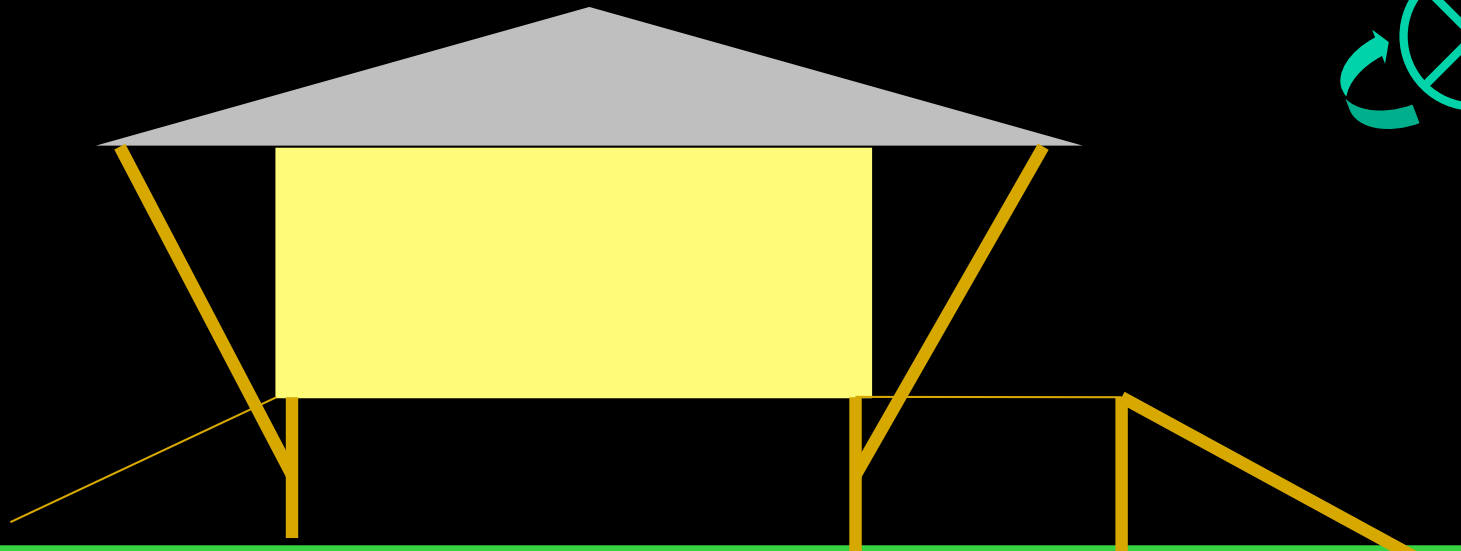
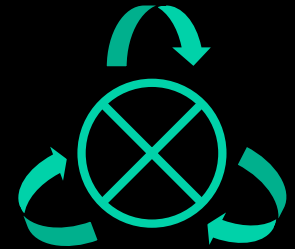


Driven piles (ram/piston/vibration in preference to hammer) in soft ground: No excavation arisings  
eco-concrete

No ground/ring beams: No excavation arisings

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# Not so light touch in poor ground



Piles in many forms  
Precast eco-concrete  
Steel Auger  
Steel Corkscrew

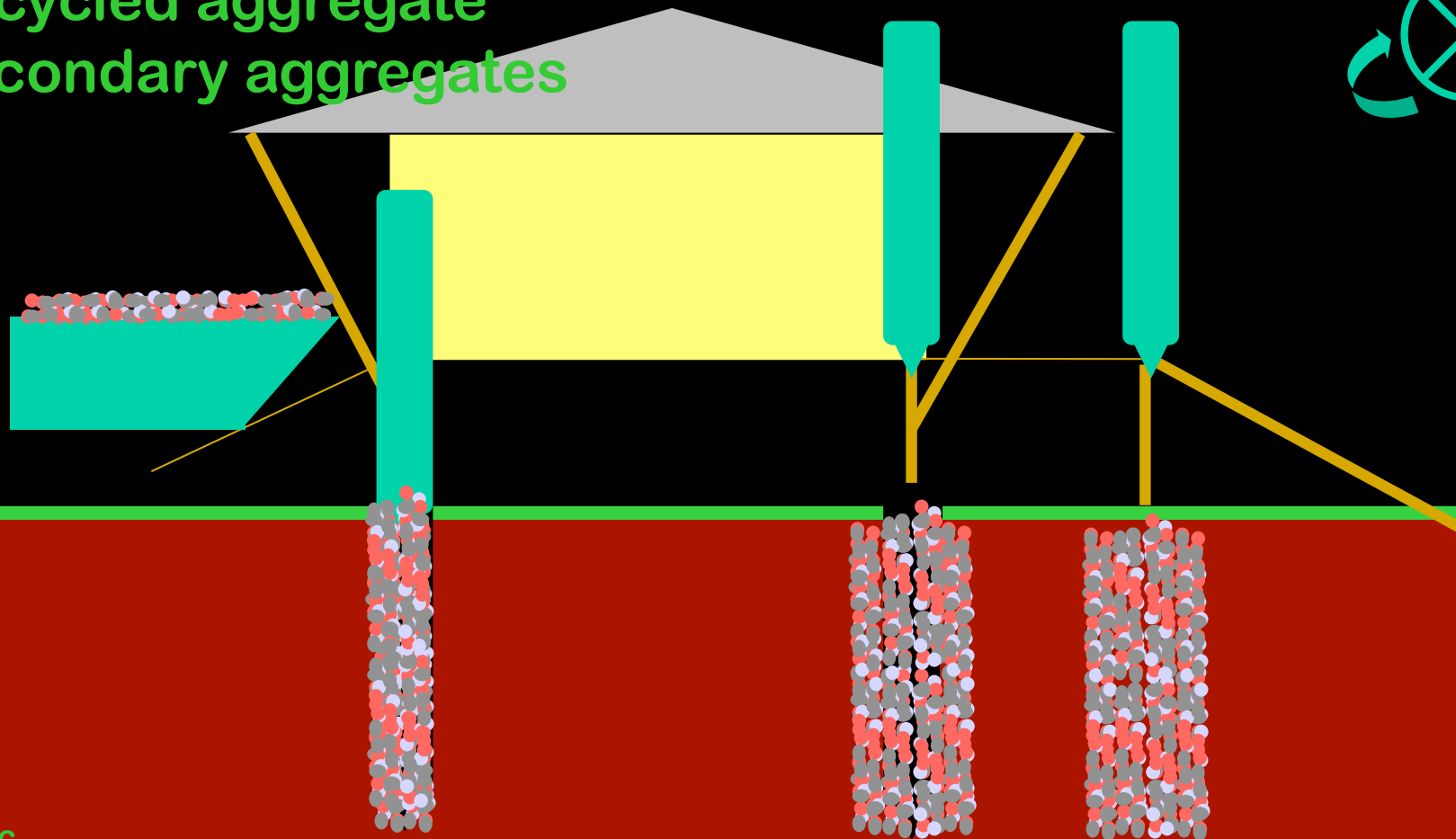
# Not so light touch in poor ground

Piles in many forms

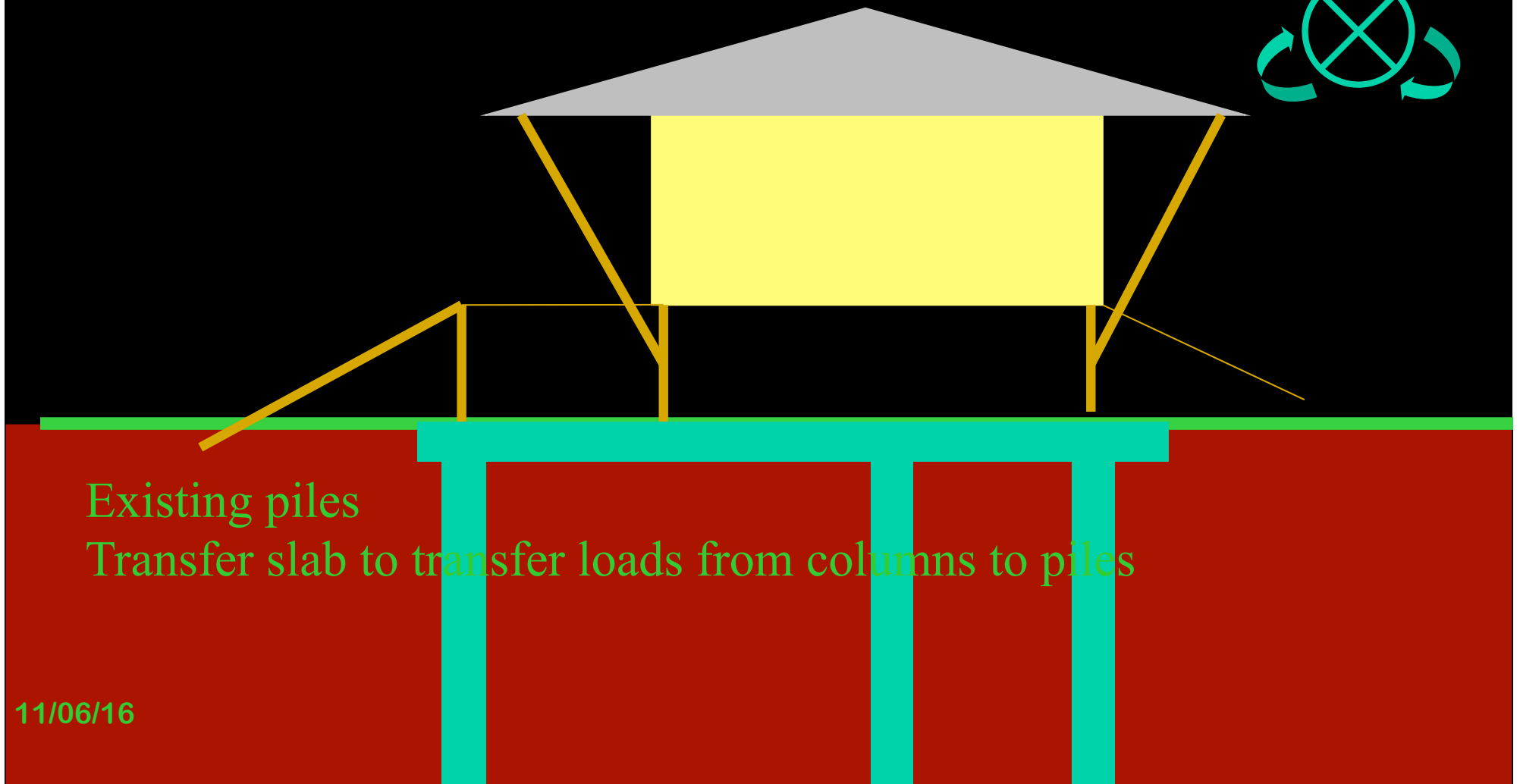
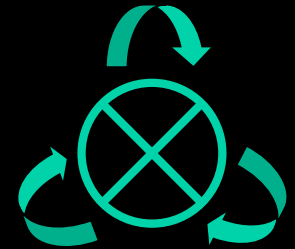
Recycled concrete aggregate vibrated pile

Recycled aggregate

Secondary aggregates

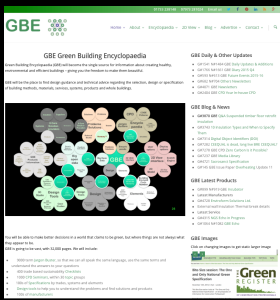


# Existing piles & Transfer slabs



Existing piles

Transfer slab to transfer loads from columns to piles



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Cycle Assessment Procedure for Eco-impacts of Materials

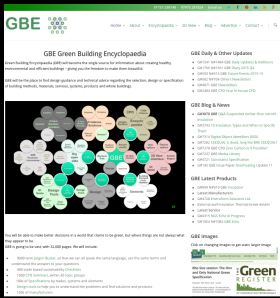


# Soil improvement for foundations



## Soil stabilisation

- **Subsoil + rainwater + agitation my vehicle vibration = muddy site**
- **Stabilise by adding:**
- **Lime, Lime & Cement or Cement**
- **Rotivate in and roller flat**
- **Forming solid base for vehicles and following trade: floor slabs, roads**



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Cycle Assessment Procedure for Eco-impacts of Materials



# Dynamic consolidation improves ground & simplifies foundations

# Dynamic Consolidation

Dynamic Consolidation of subsoil to improve load bearing capacity

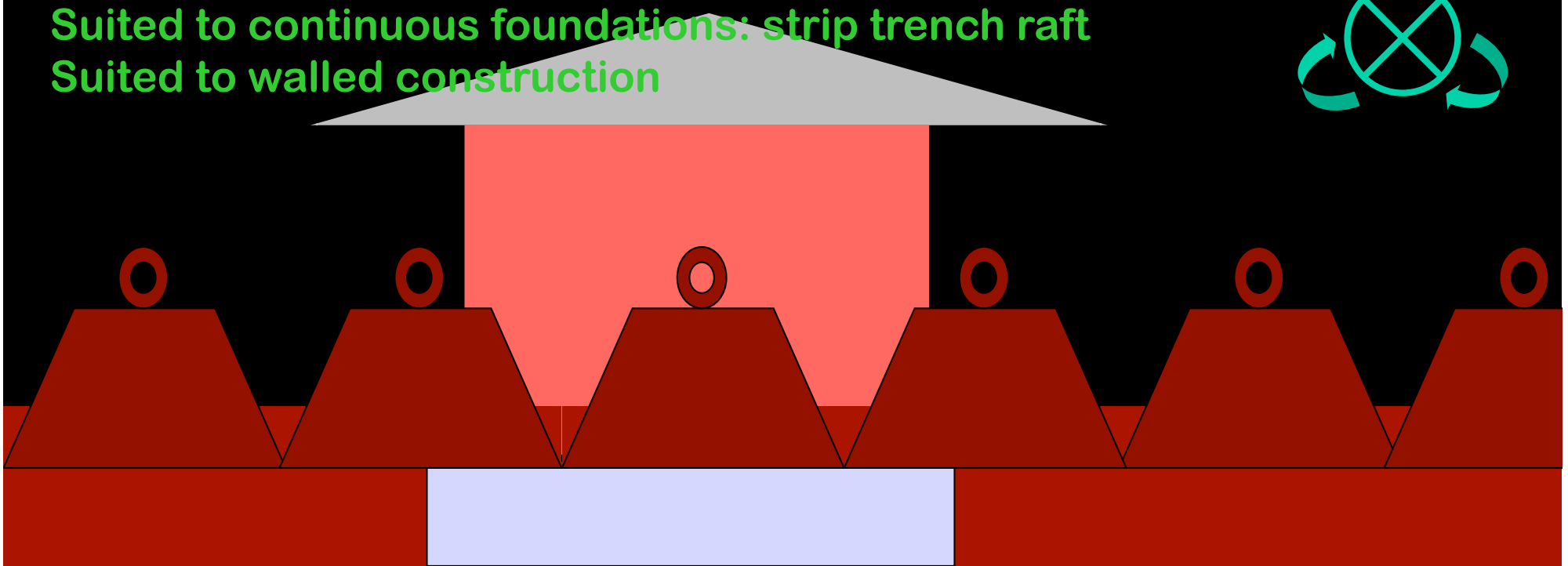
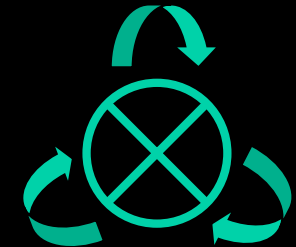
Heavy touch in poor ground

Noise and Vibration issues for neighbours

Lowering of site level

Suited to continuous foundations: strip trench raft

Suited to walled construction



# Dynamic Consolidation

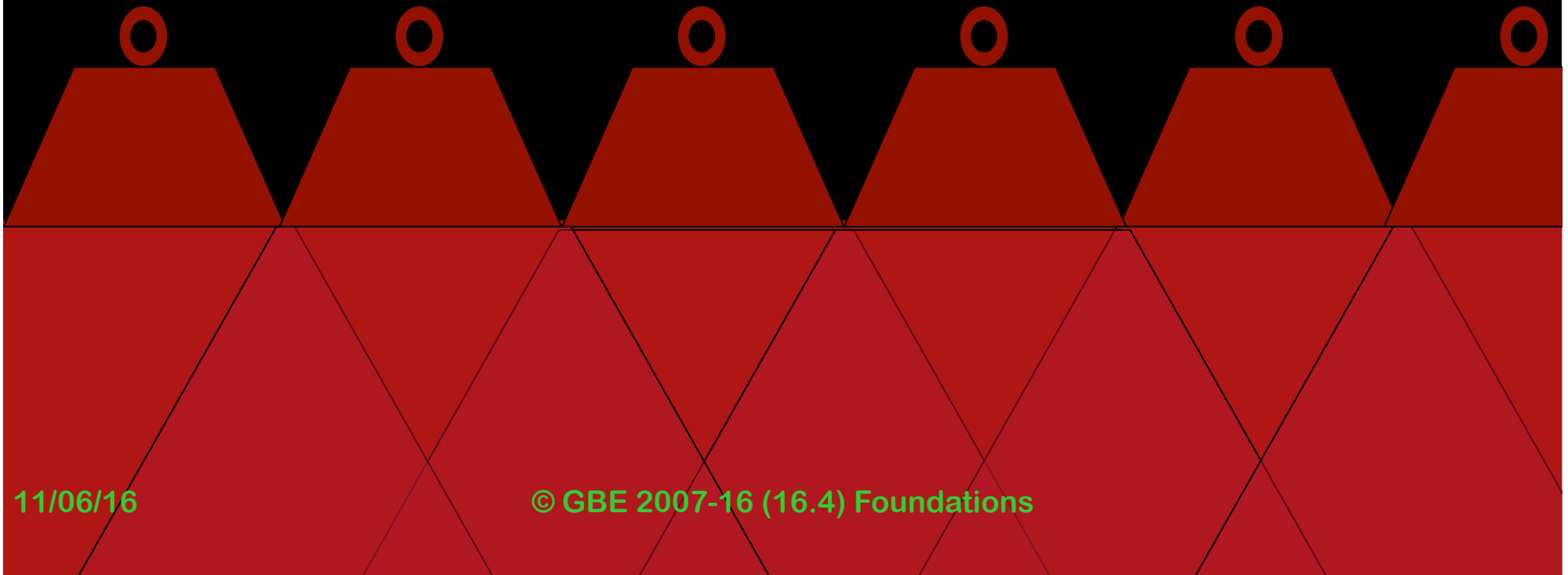
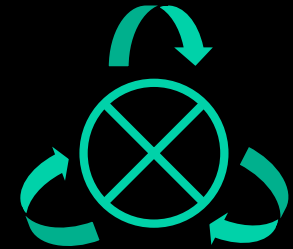
Dynamic Consolidation of subsoil to improve load bearing capacity

Heavy touch in poor ground

Spaced affects capacity lower down

Angle depends on soil types

Closer centres bring bearing capacity closer to surface



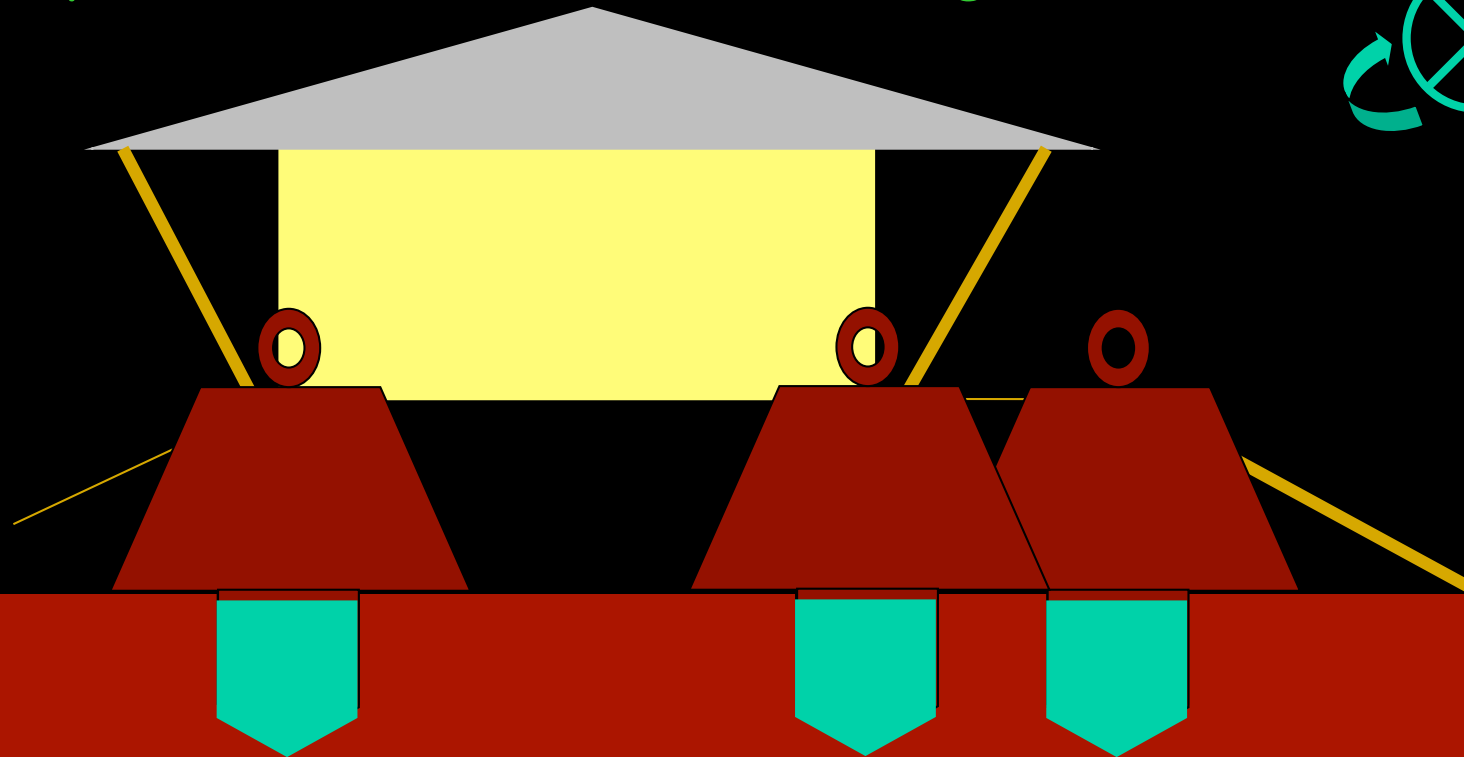
# Heavy touch in poor ground

Dynamic Consolidation of subsoil to improve load bearing capacity

Noise and Vibration issues

Lowering of site level

Pockets for pad foundation for framed buildings



# Post & framing

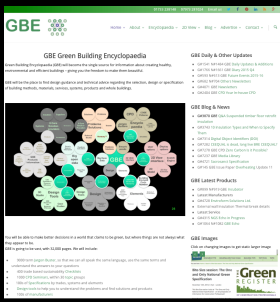
- Ideal for pad or pile foundation
- Minimal excavation
- Minimal arisings
- Or almost no foundations at all
- Children, nature & storage under



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Hedgehog Self-build Brighton

Architect: Robin Hillier



# Load-bearing wall Foundations: Raft

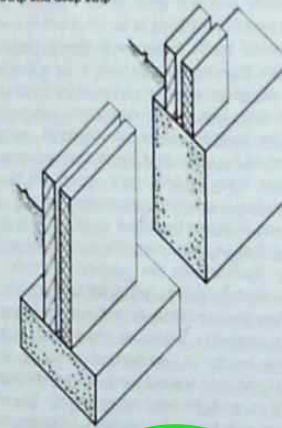
# Walled building foundations

- Raft Foundation

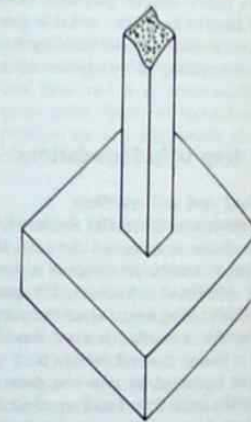
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- |  |                            |
|--|----------------------------|
| 1 Building load                              | 5 Holes for services       |
| 2 Ground level                               | 6 Construction process     |
| 3 Connection of wall or column to foundation | 7 Depth below ground level |
| 4 Foundation shape                           |                            |
| 4.1 Wall                                     |                            |
| 4.2 Thick                                    |                            |
| 4.3 Stepped                                  |                            |

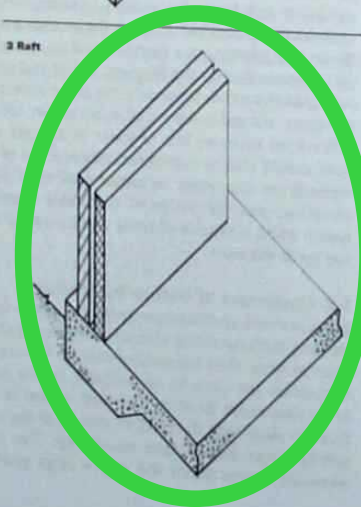
1 Strip and deep strip



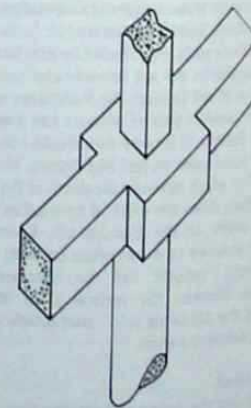
2 Pad or slab



3 Raft



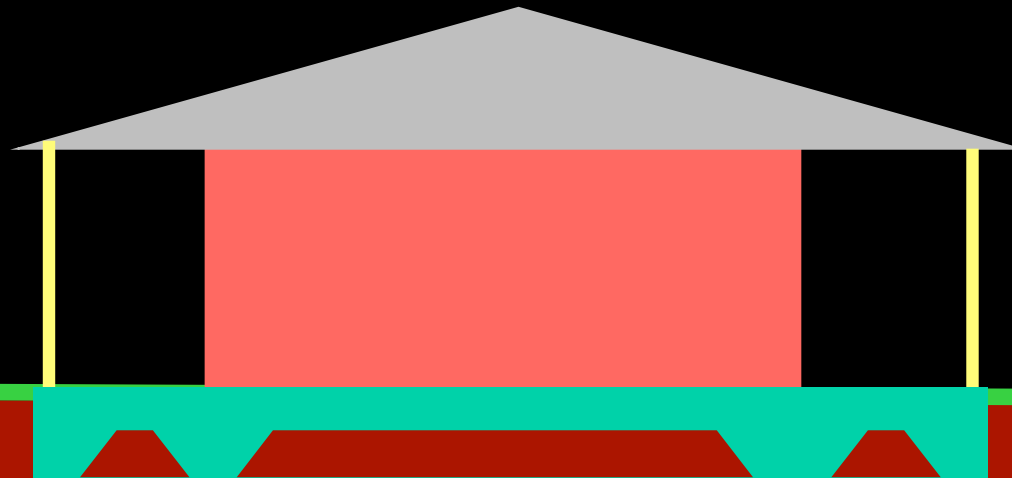
4 Pile



# Raft Foundations

- Often used in poor soil conditions
- E.g. in East Angila (East of England) Fenland on Peat which has poor load-bearing capacity will compress as water is squeezed out of the sponge like sub-soil
- The building is designed to 'float' on a raft
- The raft must be stiff to resist differential settlement
- The building and the raft should be simple in plan or extra stiff (reinforcement) to compensate
- Downstand beams leave 'dumplings' of soil in between
- Services must swivel to accommodate settlement

# Reinforced eco-concrete raft foundation on poor ground



Reinforced eco-concrete raft foundation  
In soil not prone to moisture movement: \_\_\_ mm. thick  
Displaces excavated soil



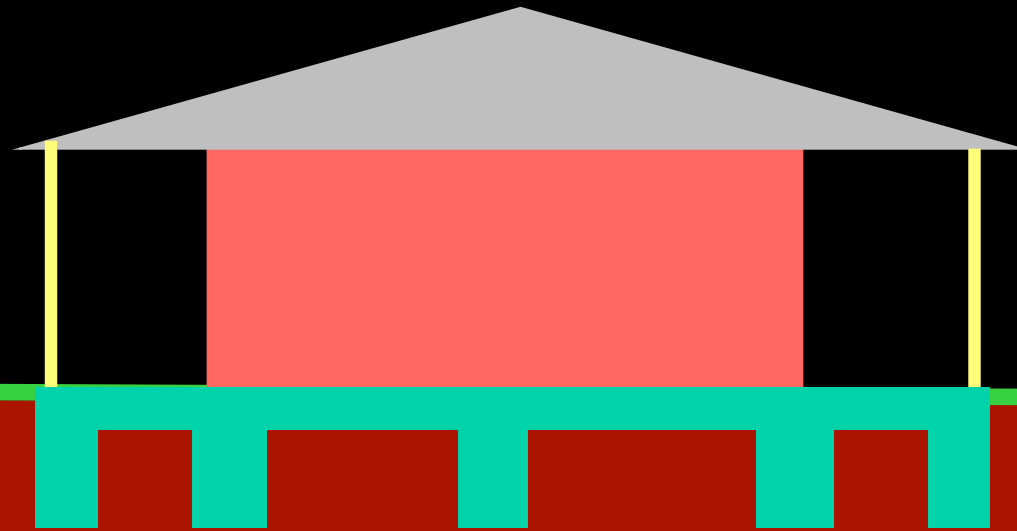
# Reinforced Concrete Raft Foundation

Ground profiled, DPM and  
reinforcement cages

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and [www.greenbuildingencyclopaedia.uk](http://www.greenbuildingencyclopaedia.uk)

# Reinforced eco-concrete raft foundation on poor ground

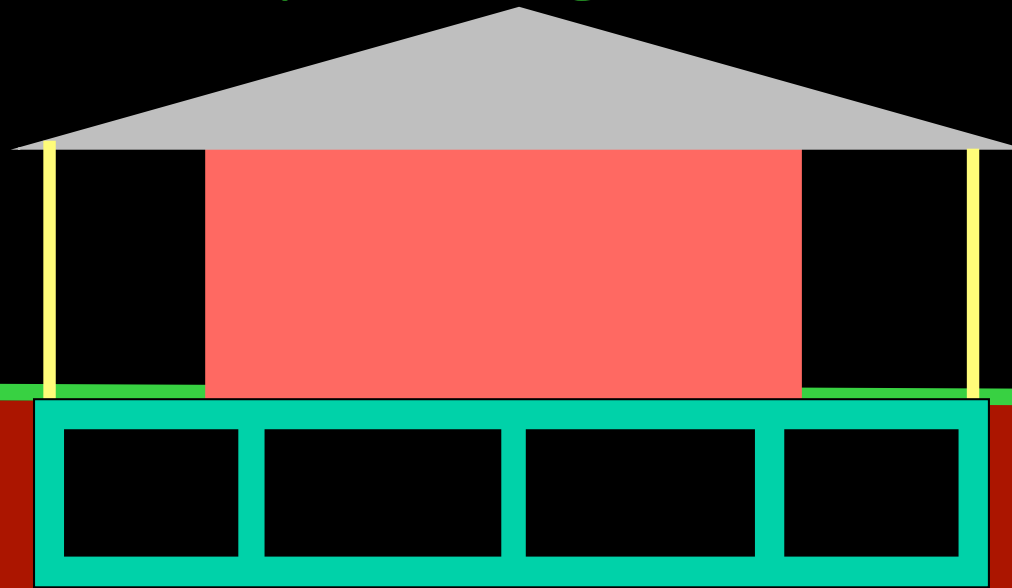
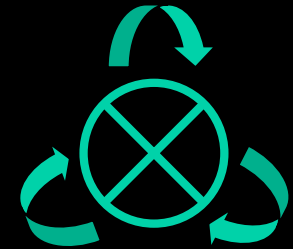


Reinforced eco-concrete raft foundation  
In clay and moisture sensitive soil: 900 mm. thick  
To resist moisture movement and frost heave  
Displaces excavated soil

# Cellular raft

- **Historically excavated soil was sent to landfill without question**
- **If poor soil is removed the raft may become thicker and it may become cellular with slabs at top and bottom**
- **It then displaces all of the soil**
- **With diminishing landfill capacity this approach is no longer economical**

# Reinforced eco-concrete Cellular Raft foundation on poor ground



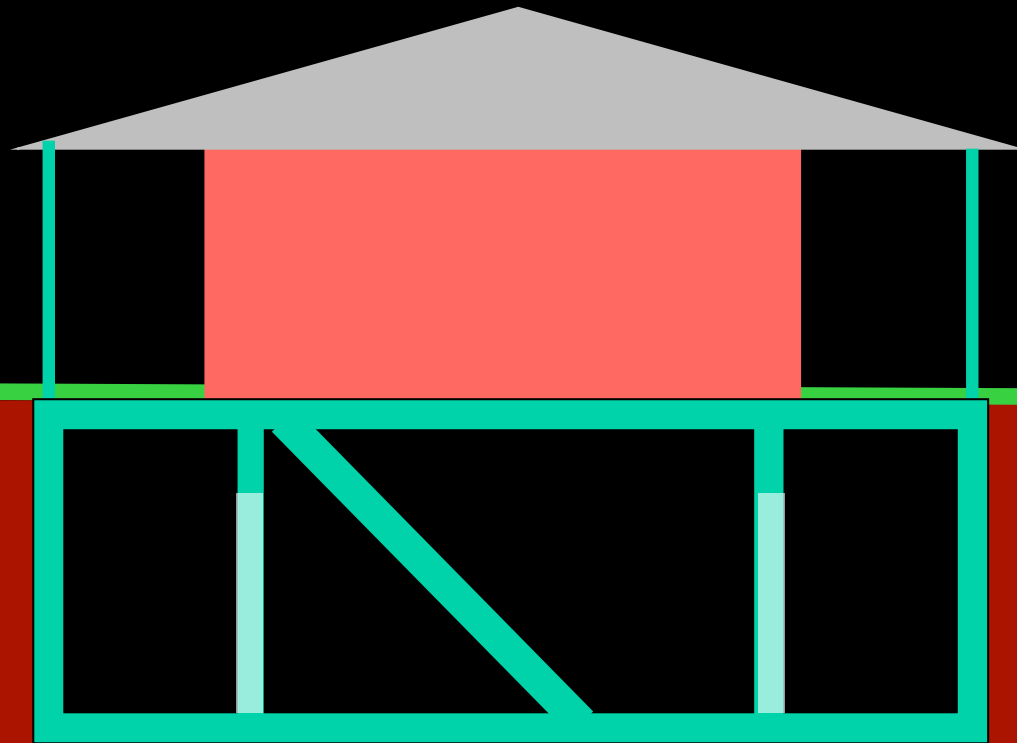
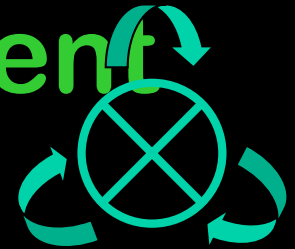
Reinforced eco-concrete raft foundation  
In clay and moisture sensitive soil: 900 mm. thick  
To resist moisture movement and frost heave  
Displaces more excavated soil



# Basement raft

- The space between the top and bottom slabs is high enough to make accommodation
- This maximises the accommodation on the site and offers opportunities for plant and storage space
- But generates considerable excavation arisings

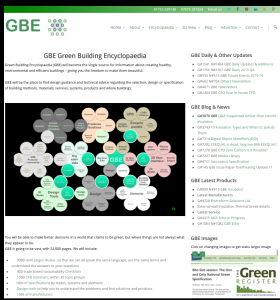
# Reinforced eco-concrete Cellular raft foundation on poor ground, turned into basement



Basement for services and storage

Reinforced eco-concrete cellular raft foundation

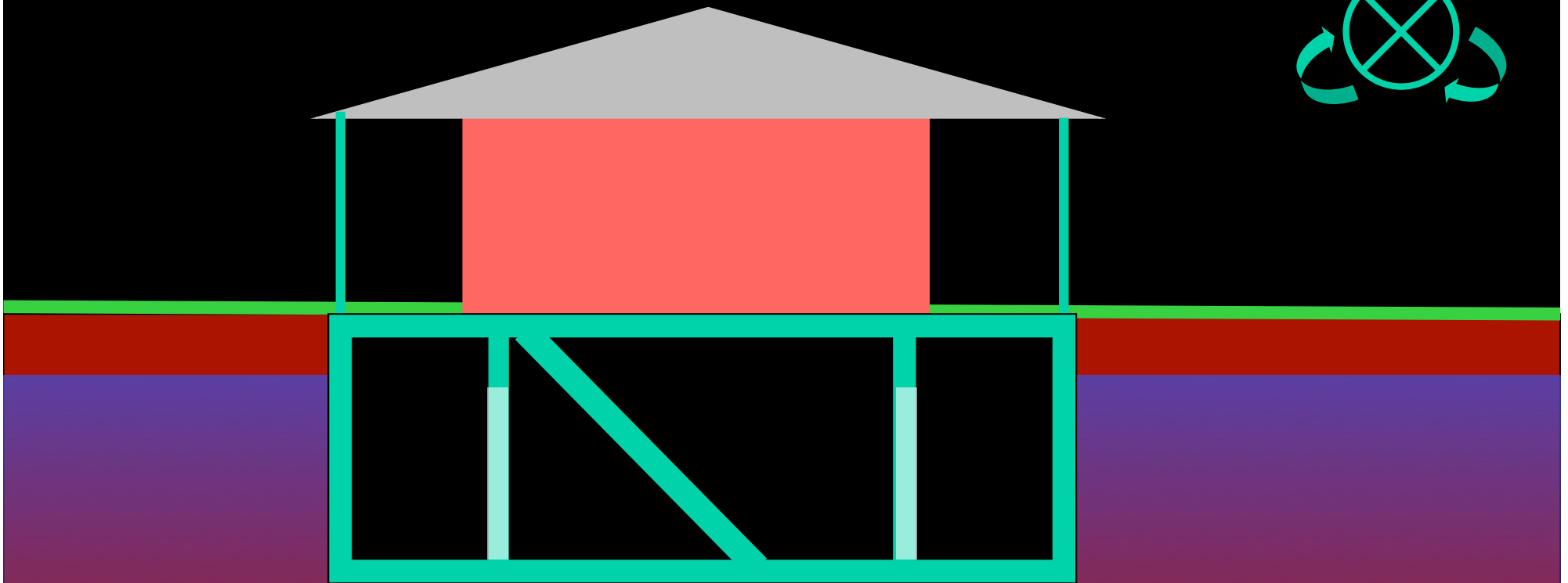
Displaces lots of excavated soil



# Floating Raft Foundations

# Cellular raft foundation on dry site

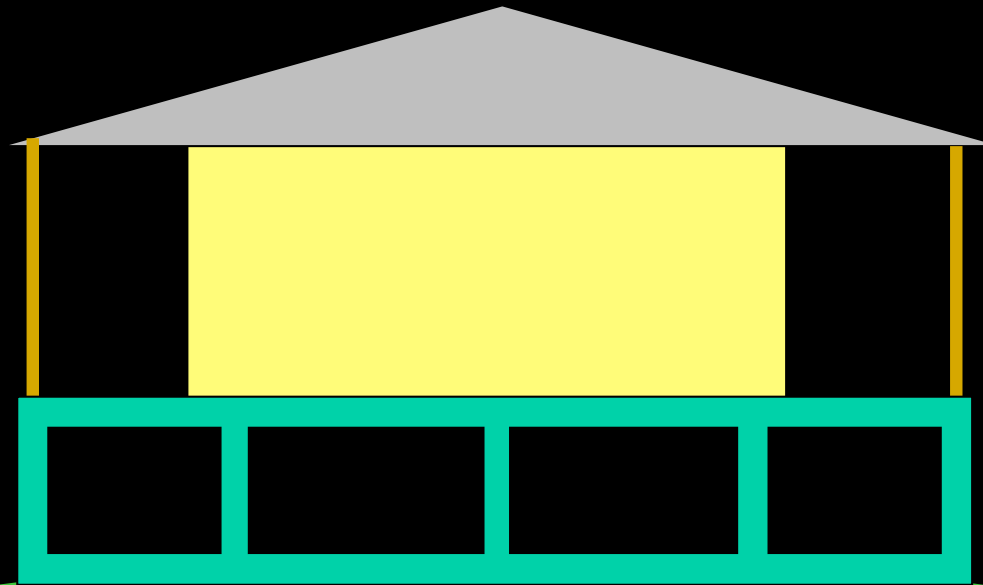
## Water table may rise



As ground water rises the basement becomes buoyant  
Risk of floatation, pressure relief wells let water in  
Sumps collect water and Pumps suck it up to sewers

11/06/16

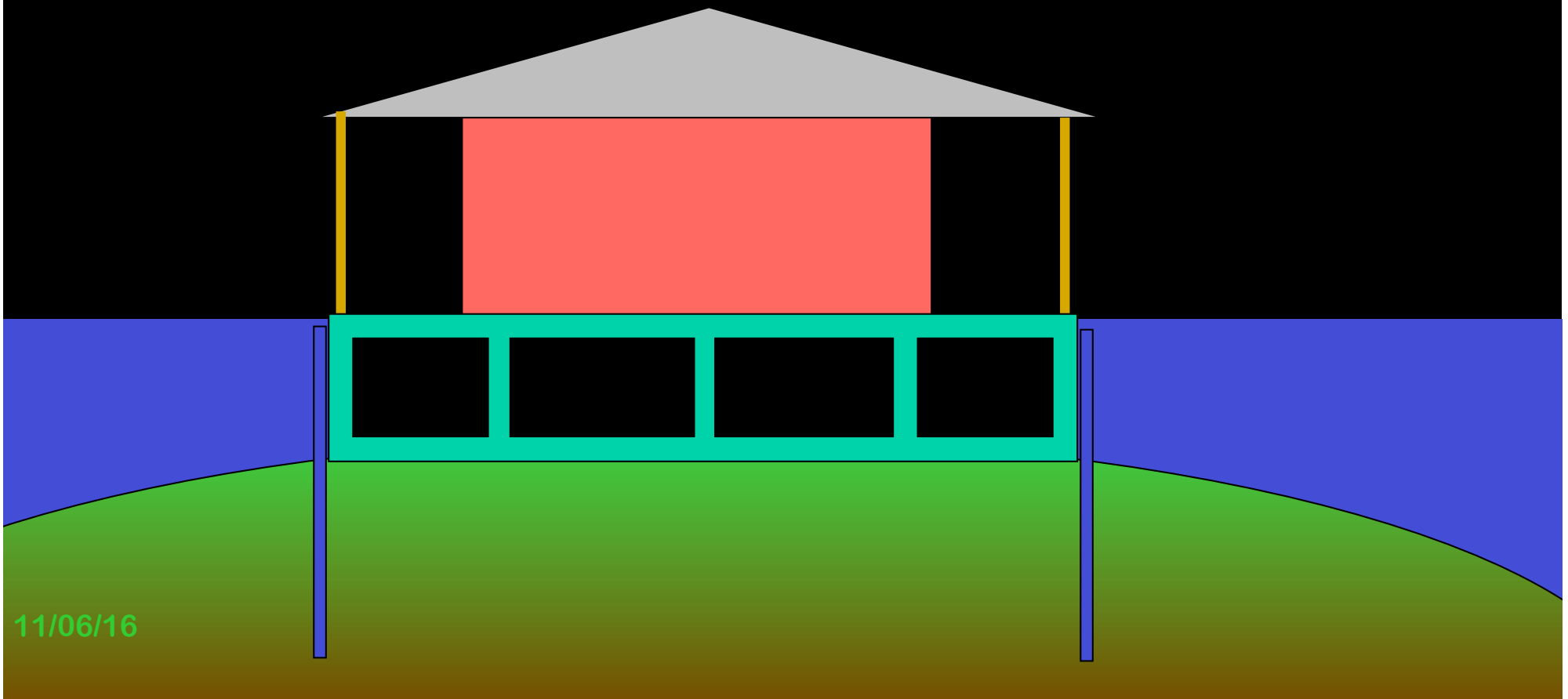
# Steel or reinforced eco-concrete Cellular Raft foundation on island subject to flooding



The Profile may be changed to have less impact  
It could be boat shaped

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# Steel or eco-concrete Cellular Raft foundation on island subject to flooding



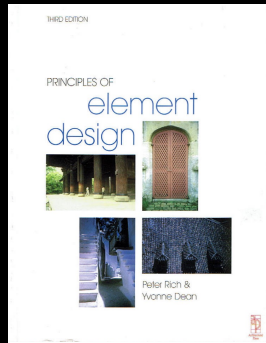
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# Resource Efficiency: Ground Floor Slab

Layered Construction  
Simplifies Details



# Solid Masonry: Raft Foundation & Concrete Floor



# Principles of Floor Design

- Floor Load
- Floor Level
- Connections of wall or column to floor
- Connection of floor to foundation
- Floor shape
- Floor thickness
- Stepping
- Holes for Services
- Construction Process
- Depth above ground level

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# Insitu eco-concrete ground floor and raft foundation on thick insulation layer

Not for clay or moisture sensitive ground

No down-stand beam

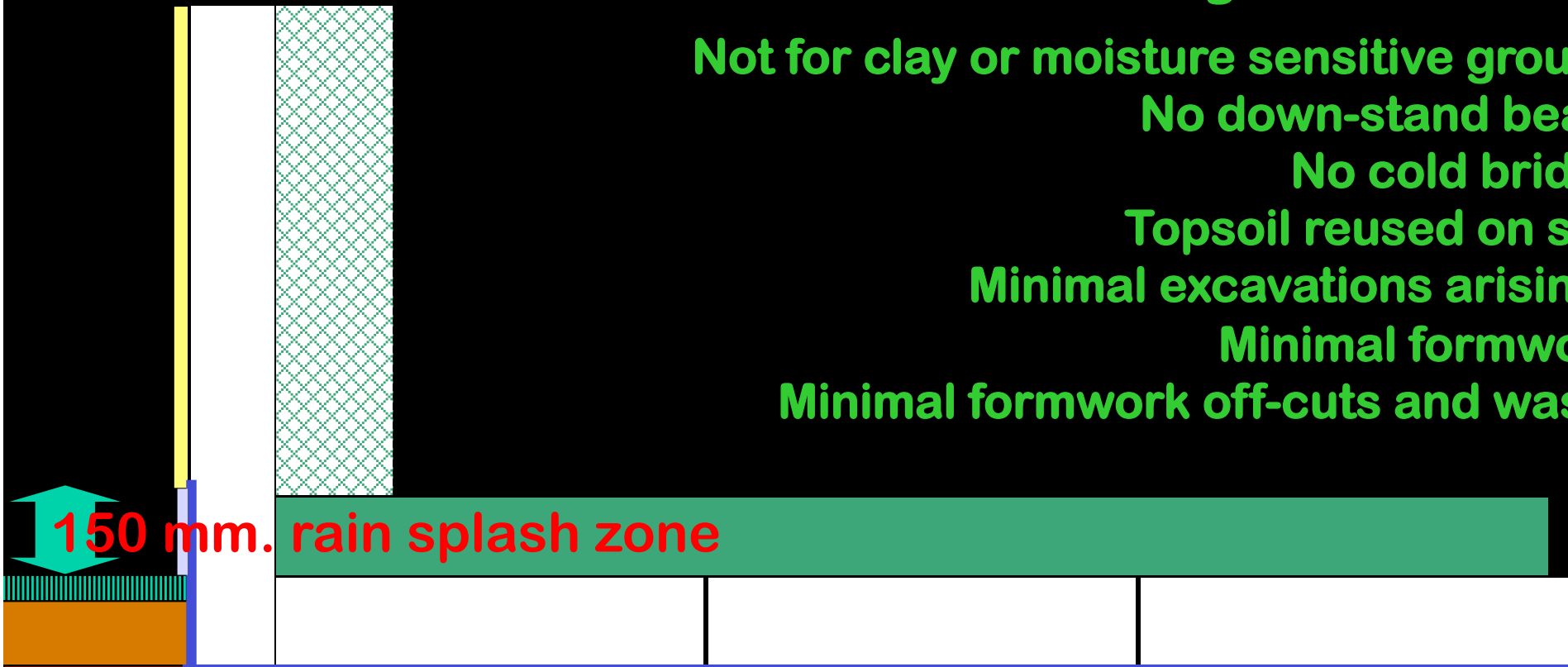
No cold bridge

Topsoil reused on site

Minimal excavations arisings

Minimal formwork

Minimal formwork off-cuts and waste



Some Structural Engineer's not happy to do this

11/06/16

Zero Carbon Buildings: insulated airtight & cold-bridge free

# Insitu eco-concrete ground floor/ raft foundation on thick insulation layer

Not for clay & moisture sensitive subsoil  
Thickening of floor at edge no cold bridges  
Topsoil reused on site  
Some excavations arisings  
Insulation as formwork  
Minimal insulation off-cuts & waste  
2 triangles cut from square  
DPM to keep insulation dry and effective

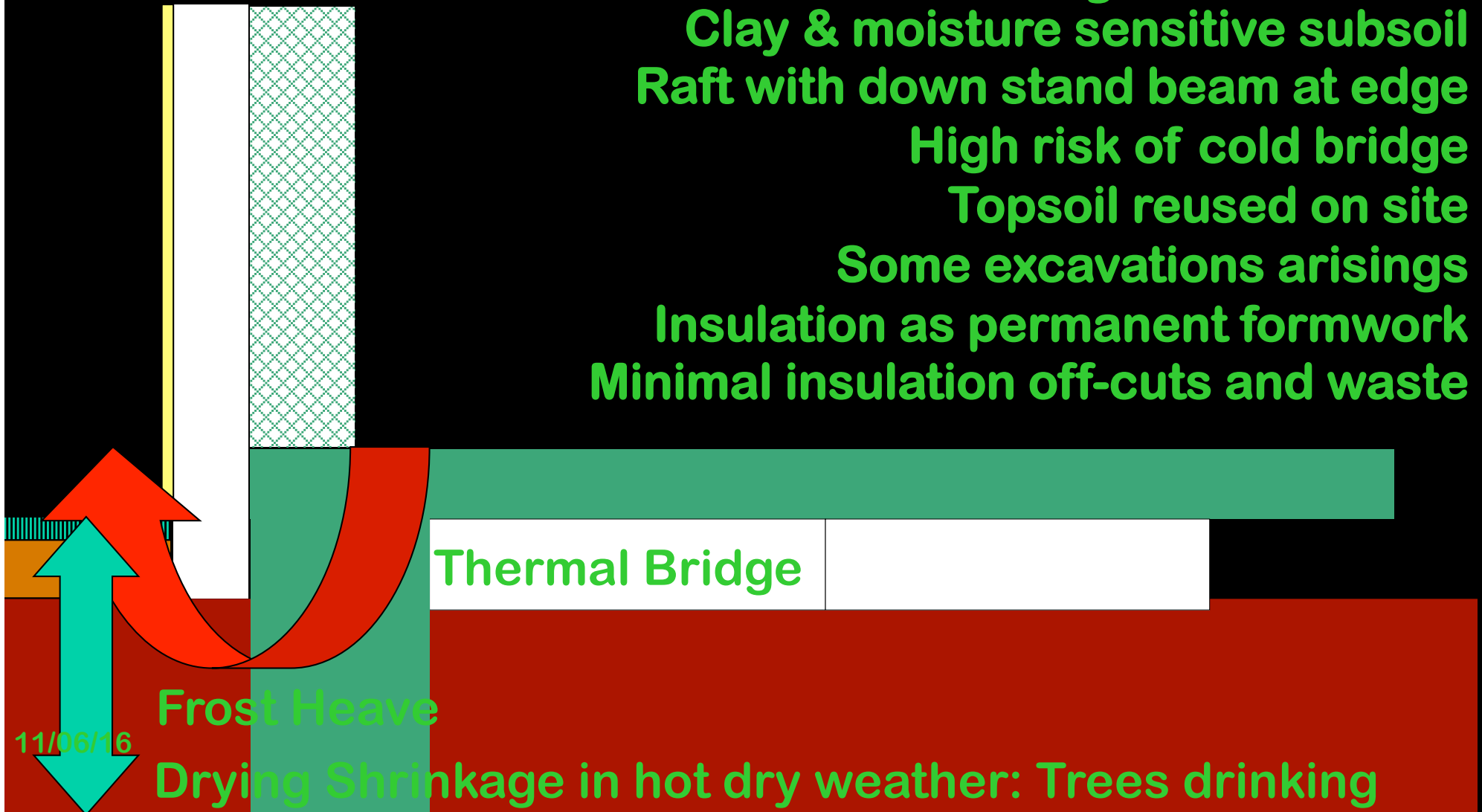


11/06/16

Some Structural Engineer's happier to do this

# Insitu eco-concrete ground floor/raft foundation on thick insulation layer

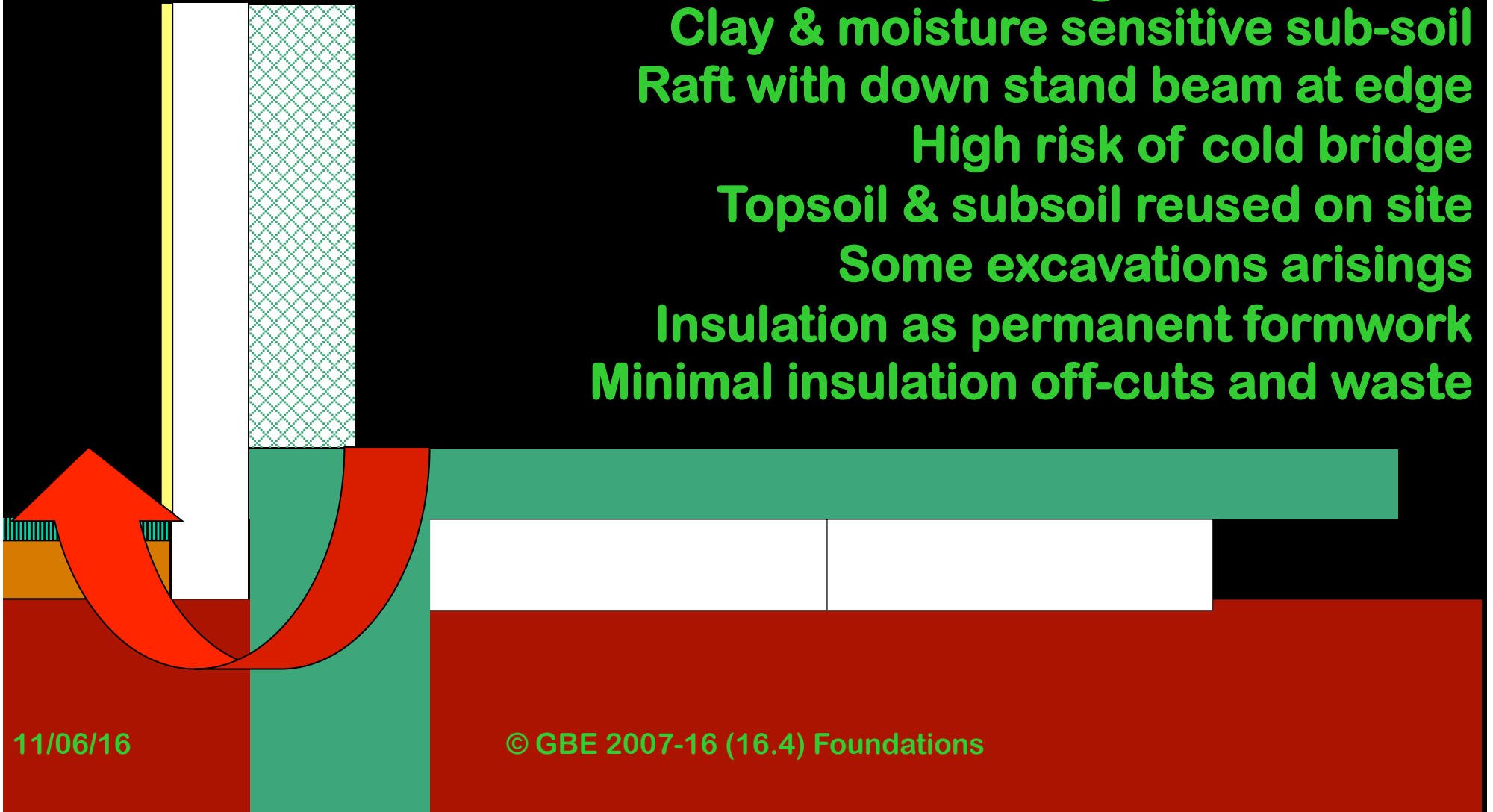
Clay & moisture sensitive subsoil  
Raft with down stand beam at edge  
High risk of cold bridge  
Topsoil reused on site  
Some excavations arising  
Insulation as permanent formwork  
Minimal insulation off-cuts and waste



11/06/16

# Insitu eco-concrete ground floor/raft foundation on thick insulation layer

Clay & moisture sensitive sub-soil  
Raft with down stand beam at edge  
High risk of cold bridge  
Topsoil & subsoil reused on site  
Some excavations arising  
Insulation as permanent formwork  
Minimal insulation off-cuts and waste



# **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**

# Zero Energy Development



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

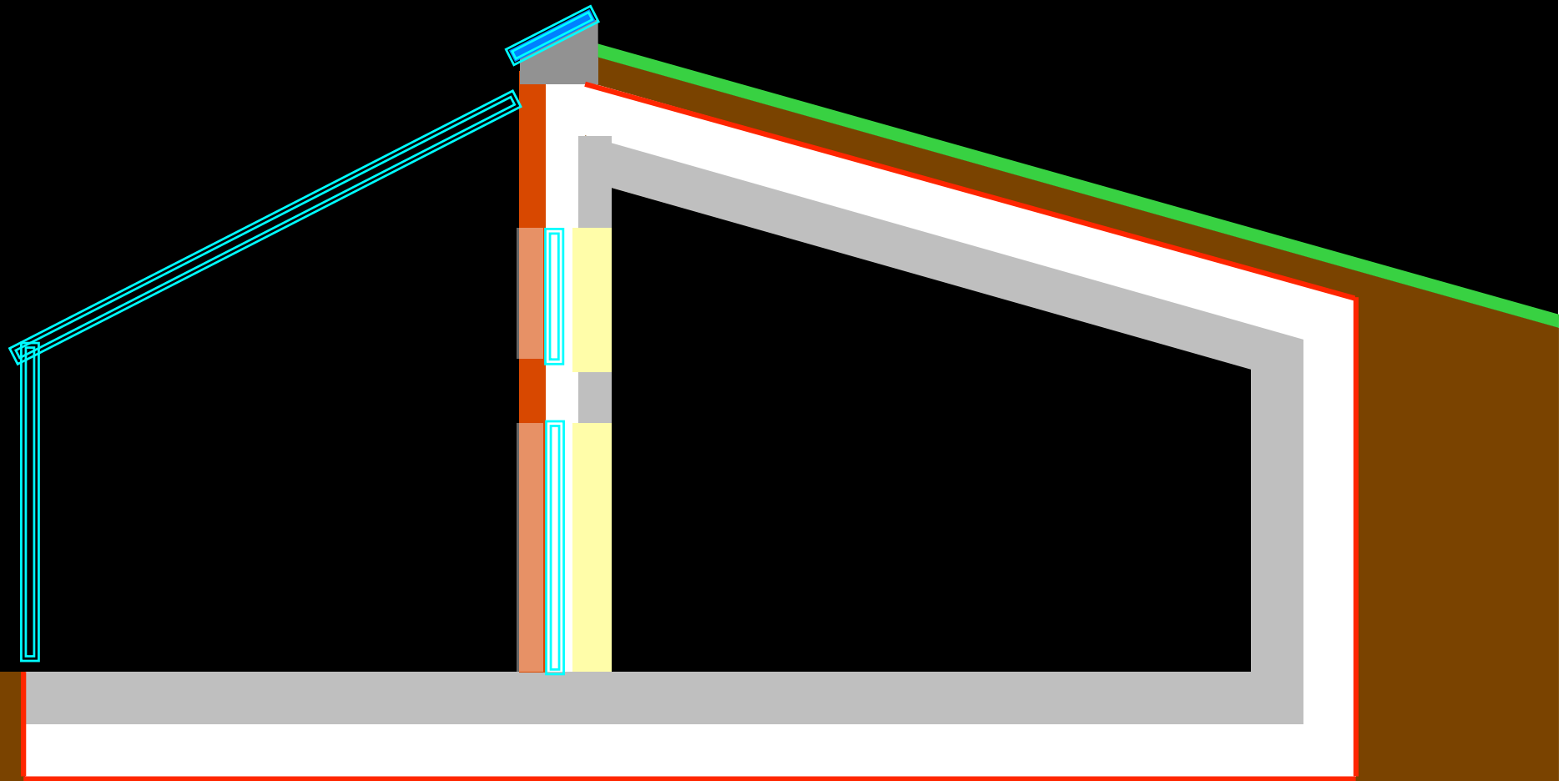
11/06/16

Hockerton Newark Nottinghamshire



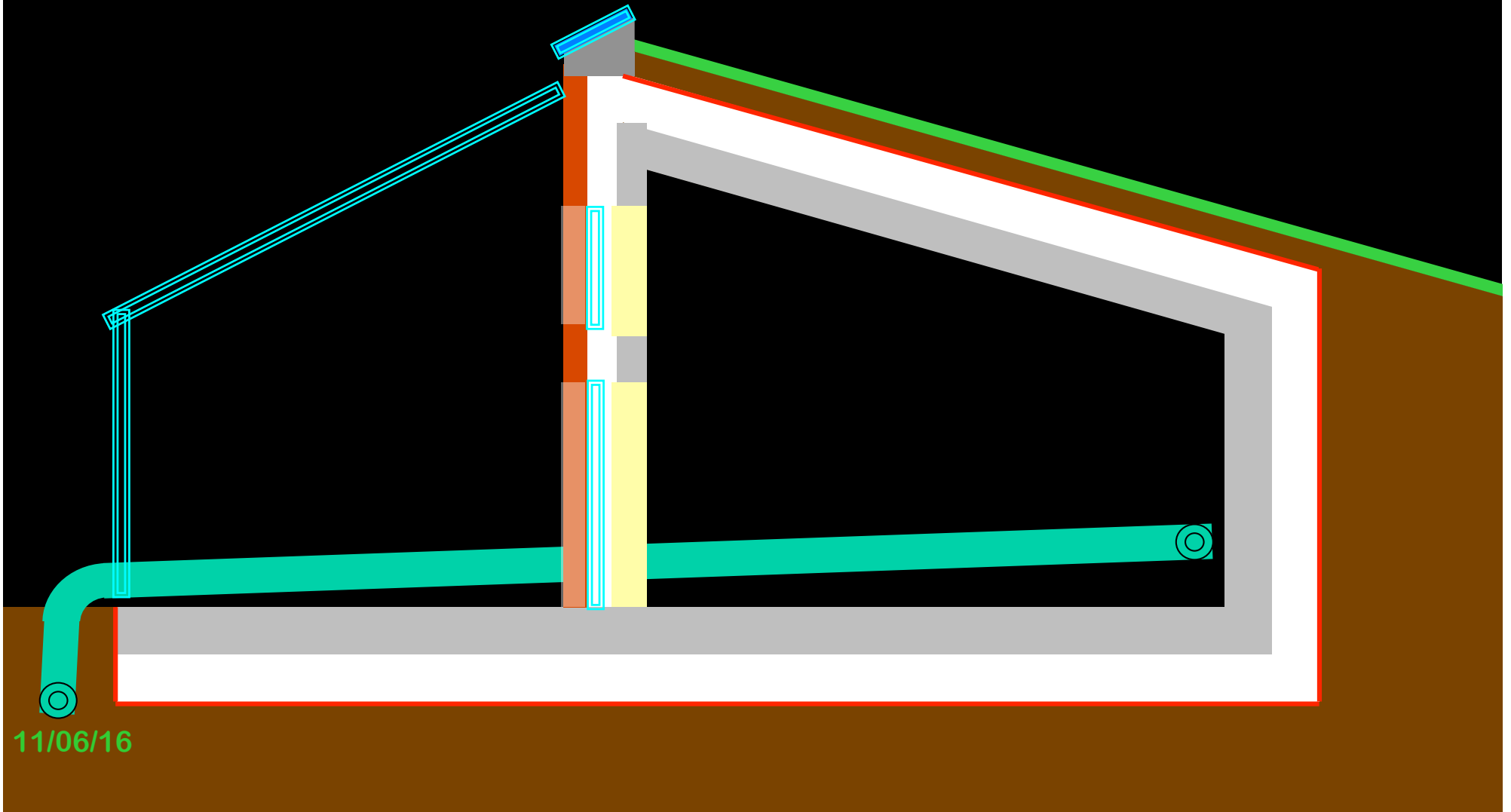
Hot house  
in the middle  
of winter

# Insulation wrapped around accommodation and thermal mass



11/06/16

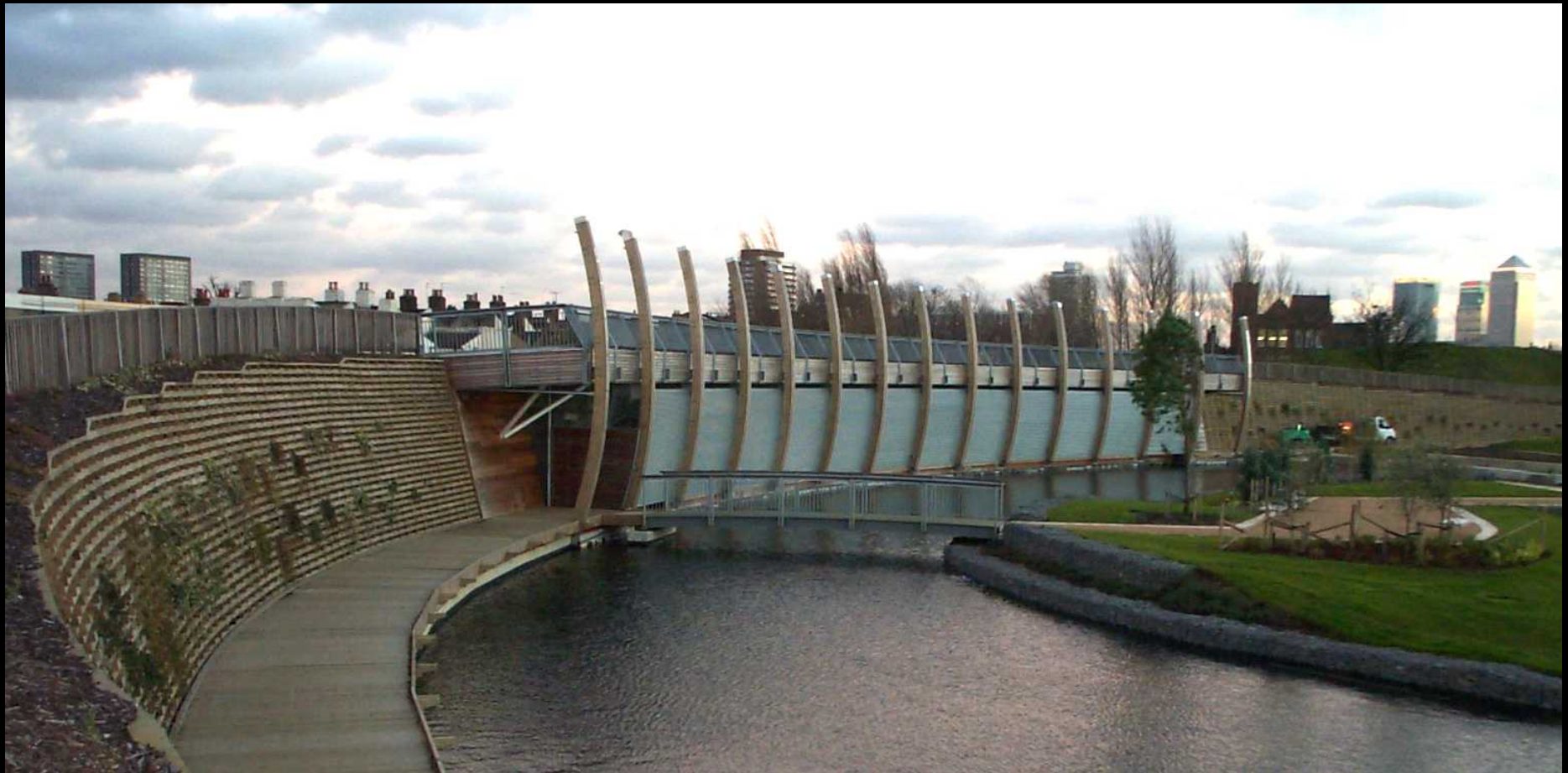
# Layering to avoid penetrations of DPM damp proof membrane



11/06/16



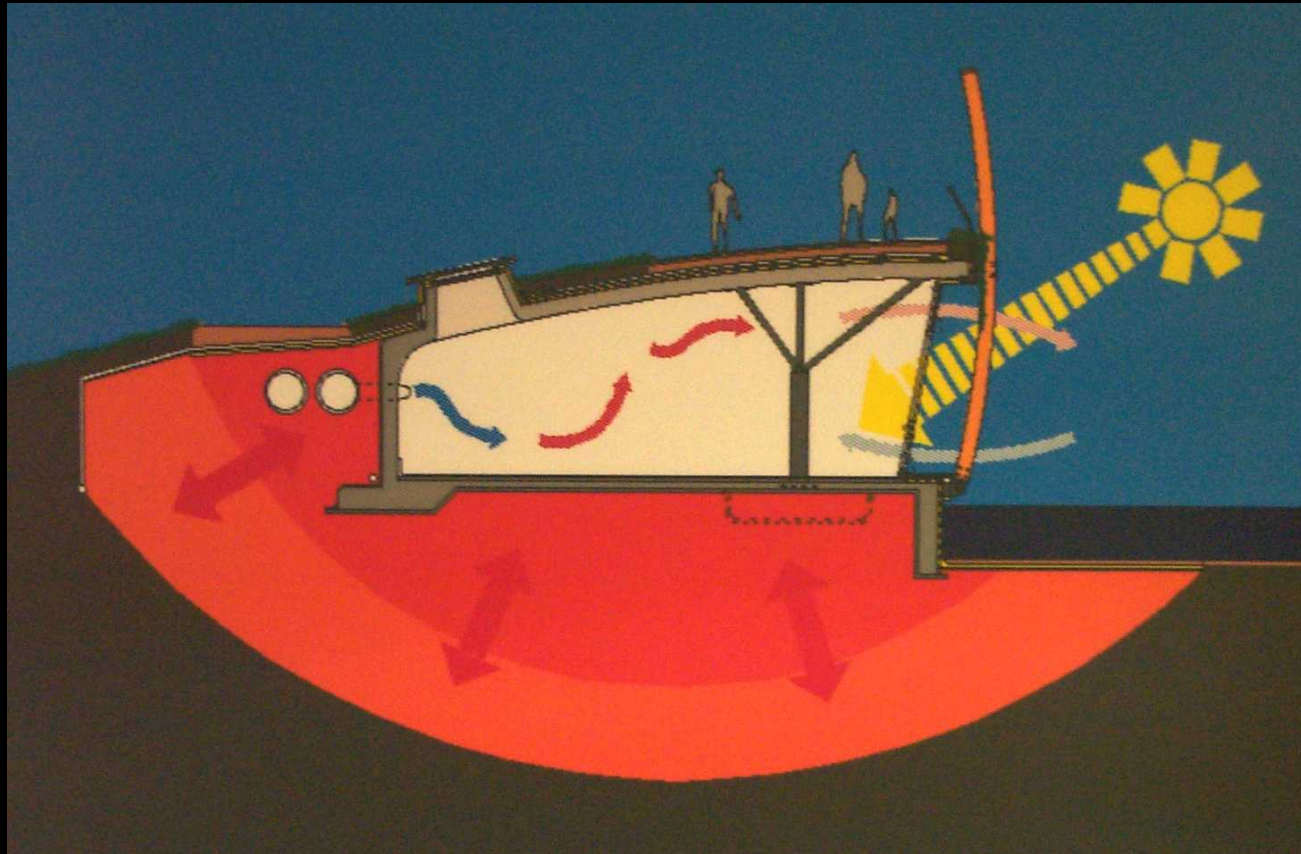
# Zero Energy Development



11/06/16

Mile End Road Park

# Zero Energy Development

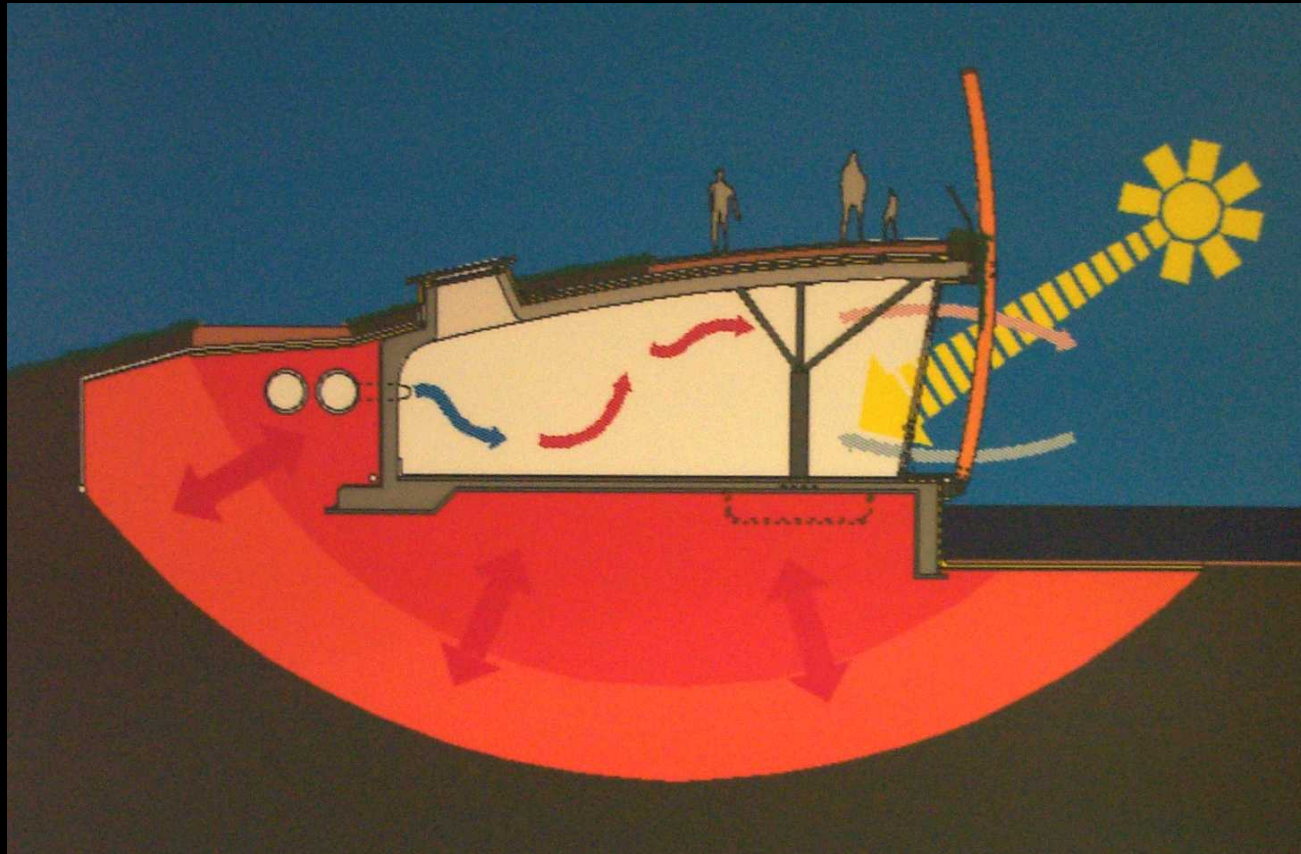


Zero Energy  
Development  
Use of  
thermal mass  
of earth to  
store heat for  
6 months

11/06/16

Mile End Road Park, E London

# Zero Energy Development

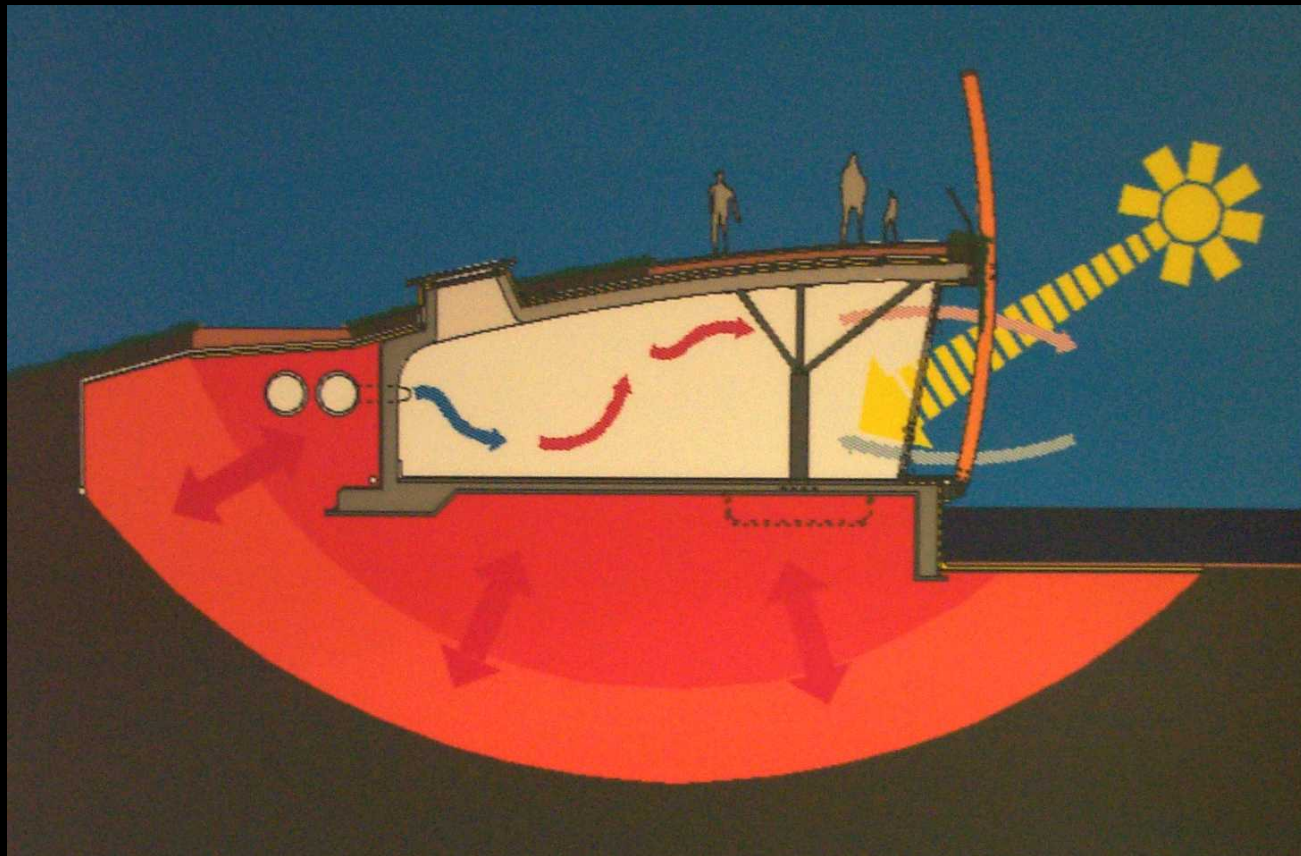


Heat transfer  
in soil 1m/mth  
6m insulation  
boards at  
perimeter  
6 months of  
heat storage

11/06/16

Mile End Road Park, E London

# Zero Energy Development



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

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Mile End Road Park, E London



# Cavity Wall Foundations: Strip or Trench Fill

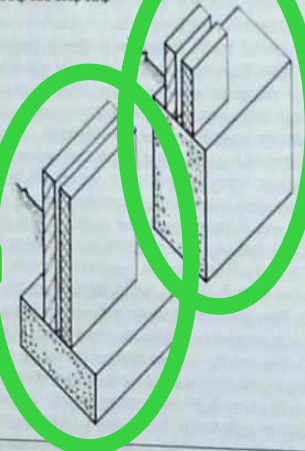
# Walled building foundations

- Strip Foundation
- Trench-fill Foundation

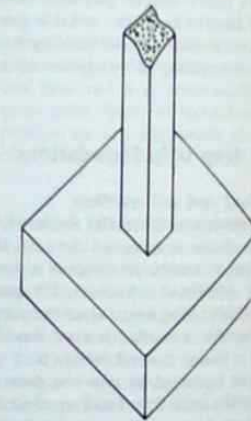
Each foundation type is discussed under the following headings:

- |  |                            |
|--|----------------------------|
| 1 Building load                              | 5 Holes for services       |
| 2 Ground level                               | 6 Construction process     |
| 3 Connection of wall or column to foundation | 7 Depth below ground level |
| 4 Foundation shape                           |                            |
| 4.1 Wall                                     |                            |
| 4.2 Thick                                    |                            |
| 4.3 Stepped                                  |                            |

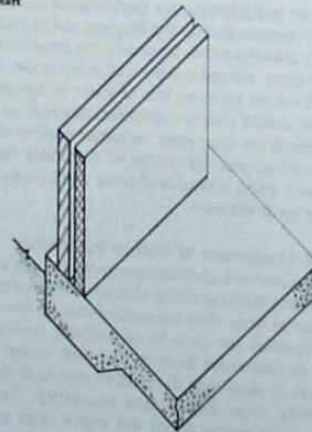
1 Strip and deep strip



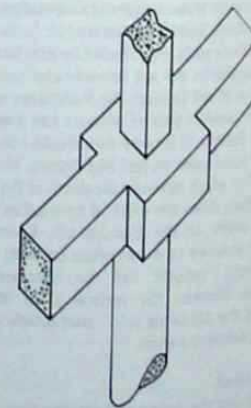
2 Pad or slab



3 Raft

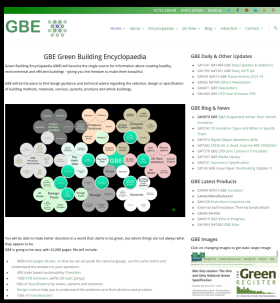


4 Pile



# Strip Foundation

- **Wide strip for labourer access either side of wall**
- **Shallow strip: less concrete (eco-concrete)**
- **But more brick, blocks, ties, concrete cavity fill**
- **H&S Risk: requires labour to work at bottom of trench which may be deep & can collapse**
- **Back filled with hardcore, consolidated in 150 mm. layers**
- **Labour intensive, costly, so avoided**



# Trench fill

- Uses narrower trench but same depth
- Uses more concrete (eco-concrete)
- Less other materials and construction below ground, no backfill
- Less labour and risks in the ground
- Less labour intensive so faster, cheap and chosen

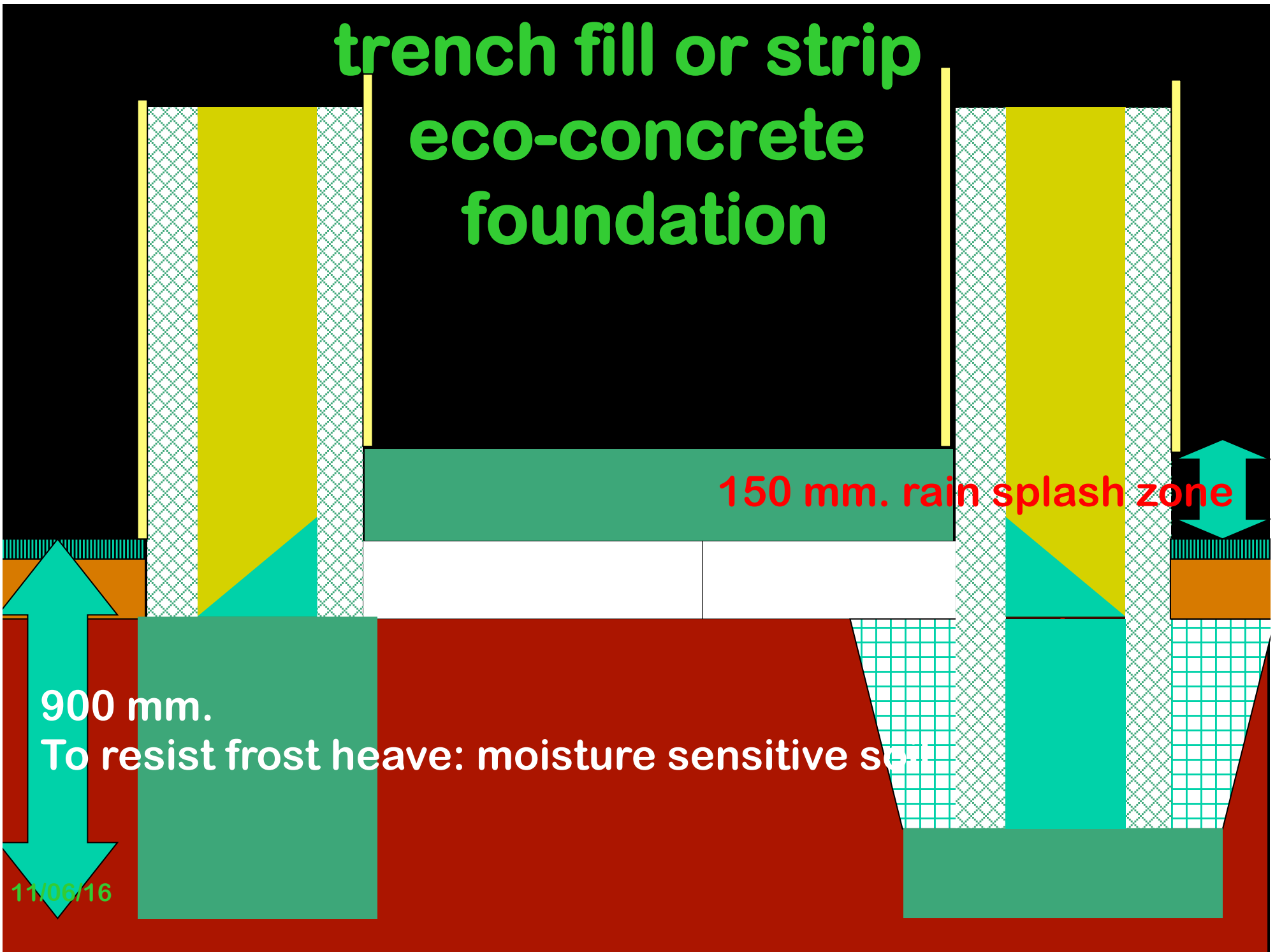
# trench fill or strip eco-concrete foundation

150 mm. rain splash zone

900 mm.

To resist frost heave: moisture sensitive soil

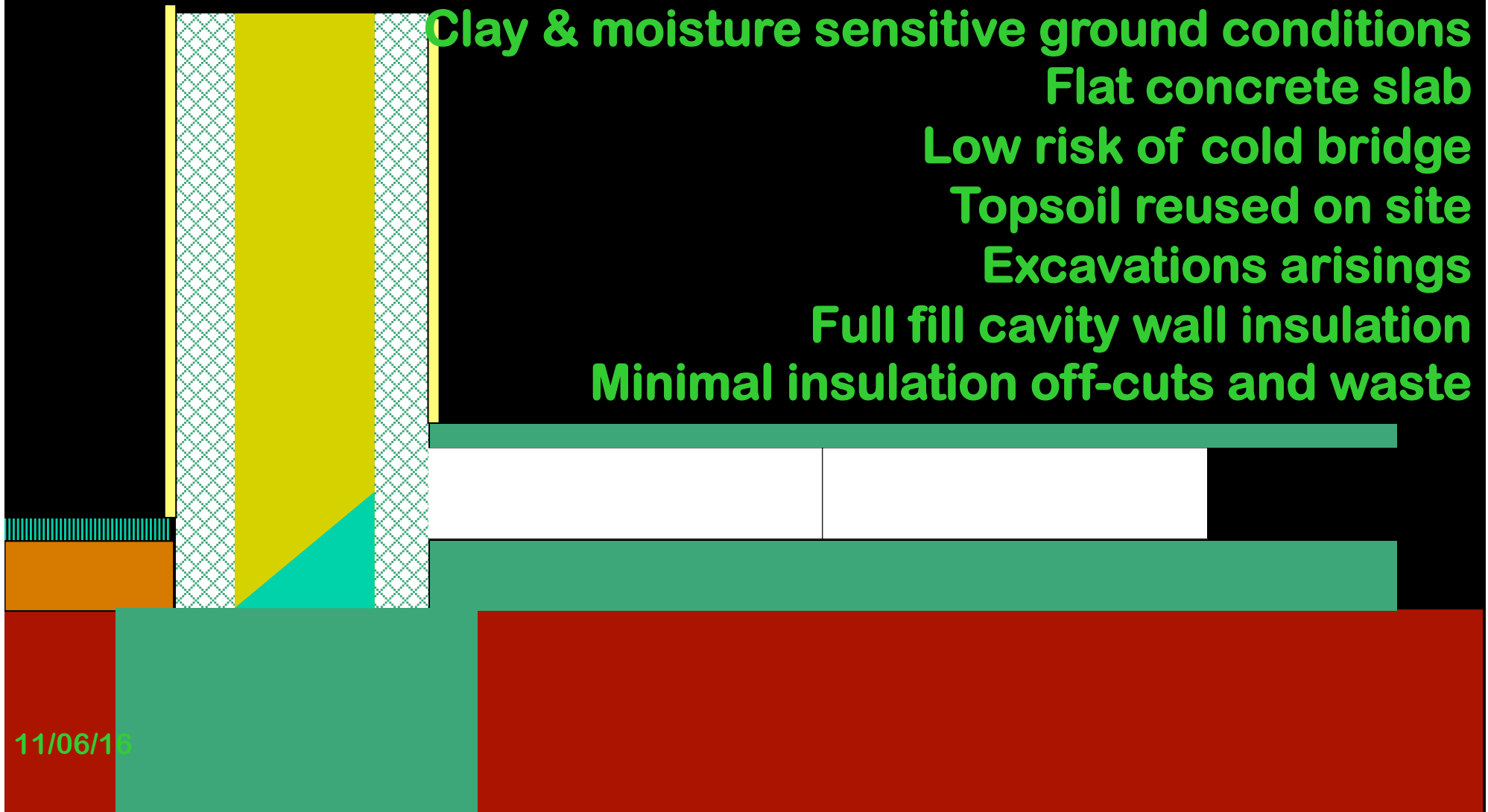
11/06/16



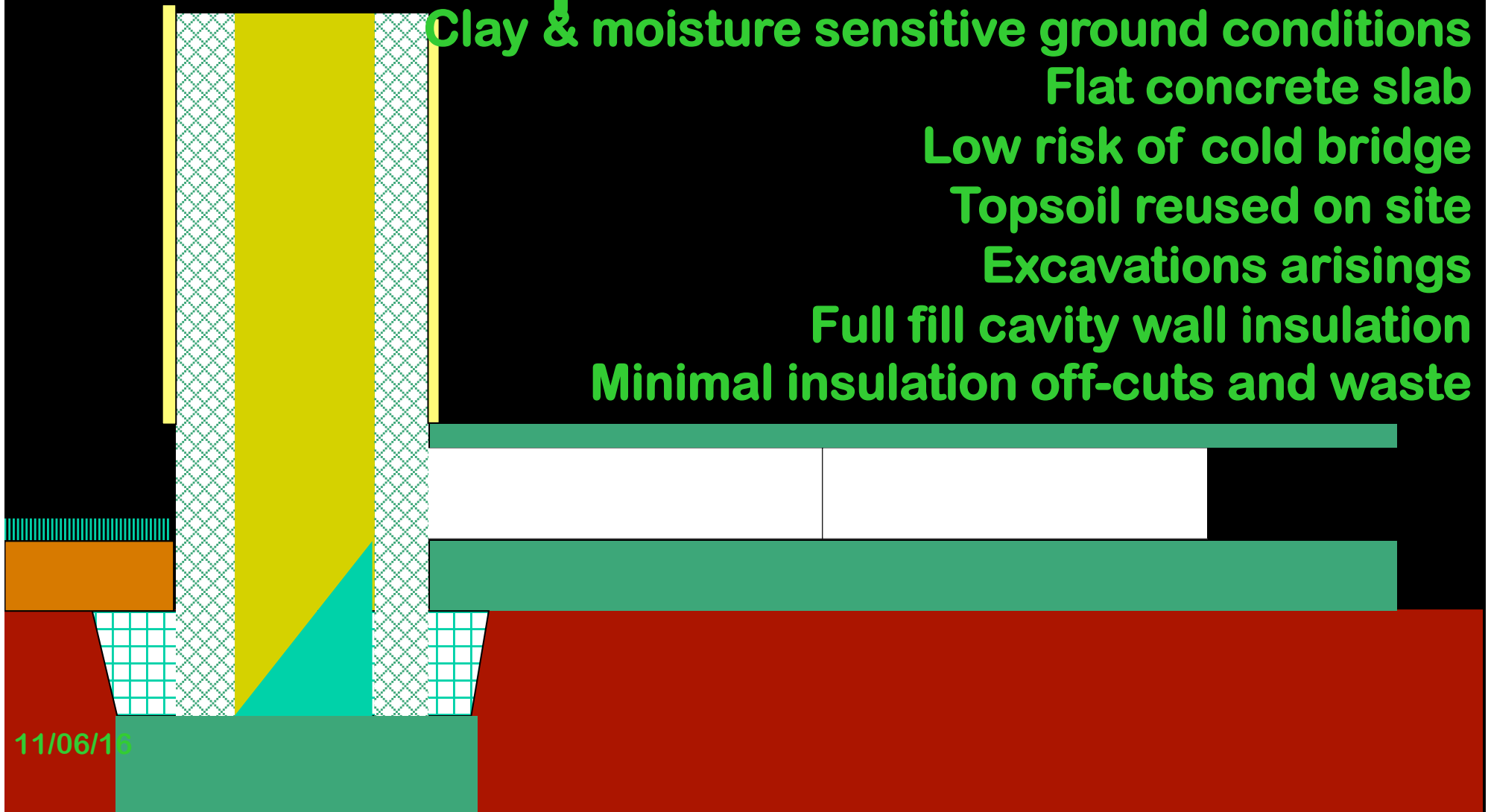
# Insitu eco-concrete ground floor on thick insulation layer trench fill foundation

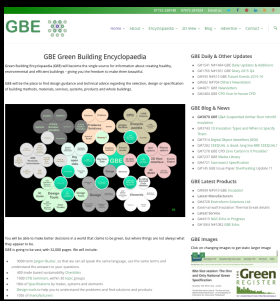


# Thick insulation layer on Insitu eco-concrete ground floor trench fill foundation



# Thick insulation layer on Insitu eco-concrete ground floor Strip foundation





# Clay heave Collapsible board

# 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



# GreenSpec



- Home
- Products
- Manufacturers
- Specifications (available 2007)
- Materials
- Energy
- Checklist
- Code for Sustainable Homes
- The Low Carbon House
- Design
- Image Bank
- Refurbishment
- Forums
- Site Waste
- Durability
- Suppliers & Installers
- Fabricators
- Reclamation
- Craftsmen
- Policies & Strategies
- Research & Papers
- Resources
- CPD

## Dufaylite 'Clayboard'

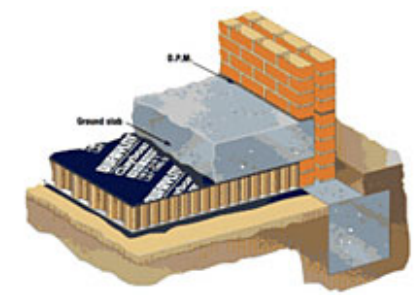
### Void formation system

"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 accommodate clay expansion without exerting undue pressure on the structure below.

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

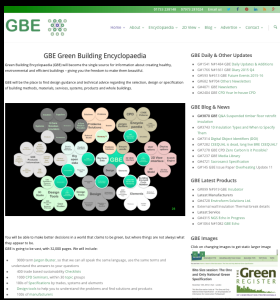


Material/s:	paper
Environmental statement:	no
BRE Ecopoints:	unrated
BRE Environmental profile:	unrated
Other environmental standards:	none
3rd party accreditation:	BBA cert 98/3528

11/06/16

# Marketing

- ‘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 accommodate clay expansion without exerting undue pressure on the structure below.
- The resulting void continues to accommodate natural soil shrinkage and expansion.’



# GBE

[www.GreenBuildingEncyclopaedia.uk](http://www.GreenBuildingEncyclopaedia.uk)

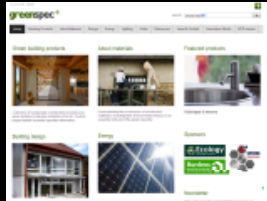


# CAP'EM

Cycle Assessment Procedure for Eco-impacts of Materials



# Ground Floor

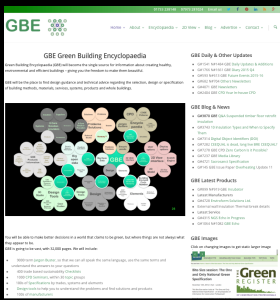


# (13.1) Ground Floor

(13.4) Ground floor: on ground, suspended

(13.9) Proofing, membranes, insulation

Another GBS CPD/Lecture file to download  
and [www.greenbuildingencyclopaedia.uk](http://www.greenbuildingencyclopaedia.uk)



# GBE

[www.GreenBuildingEncyclopaedia.uk](http://www.GreenBuildingEncyclopaedia.uk)



# CAP'EM

Cycle Assessment Procedure for Eco-impacts of Materials

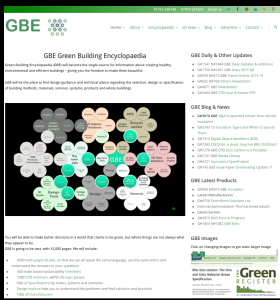


# Resource Efficiency



# Reuse of what you find on site

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



# GBE

[www.GreenBuildingEncyclopaedia.uk](http://www.GreenBuildingEncyclopaedia.uk)

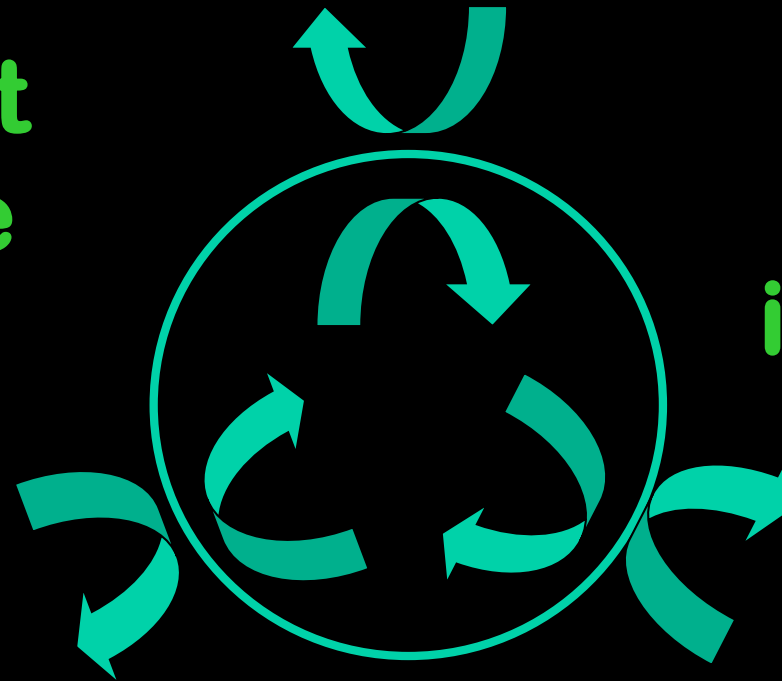
# CAP'EM

Cycle Assessment Procedure for Eco-impacts of Materials

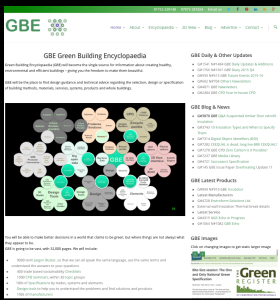


# Site Autonomy

No export  
from site



No  
materials  
imported to  
site



# GBE

[www.GreenBuildingEncyclopaedia.uk](http://www.GreenBuildingEncyclopaedia.uk)

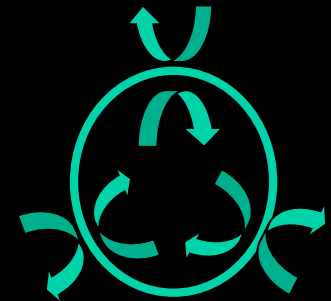


# CAP'EM

Cycle Assessment Procedure for Eco-impacts of Materials



# Cut and Fill

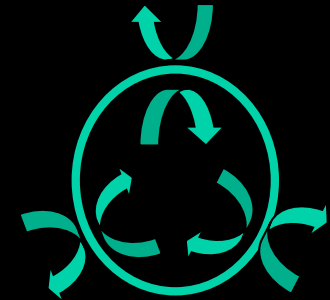


## In principle a simple idea

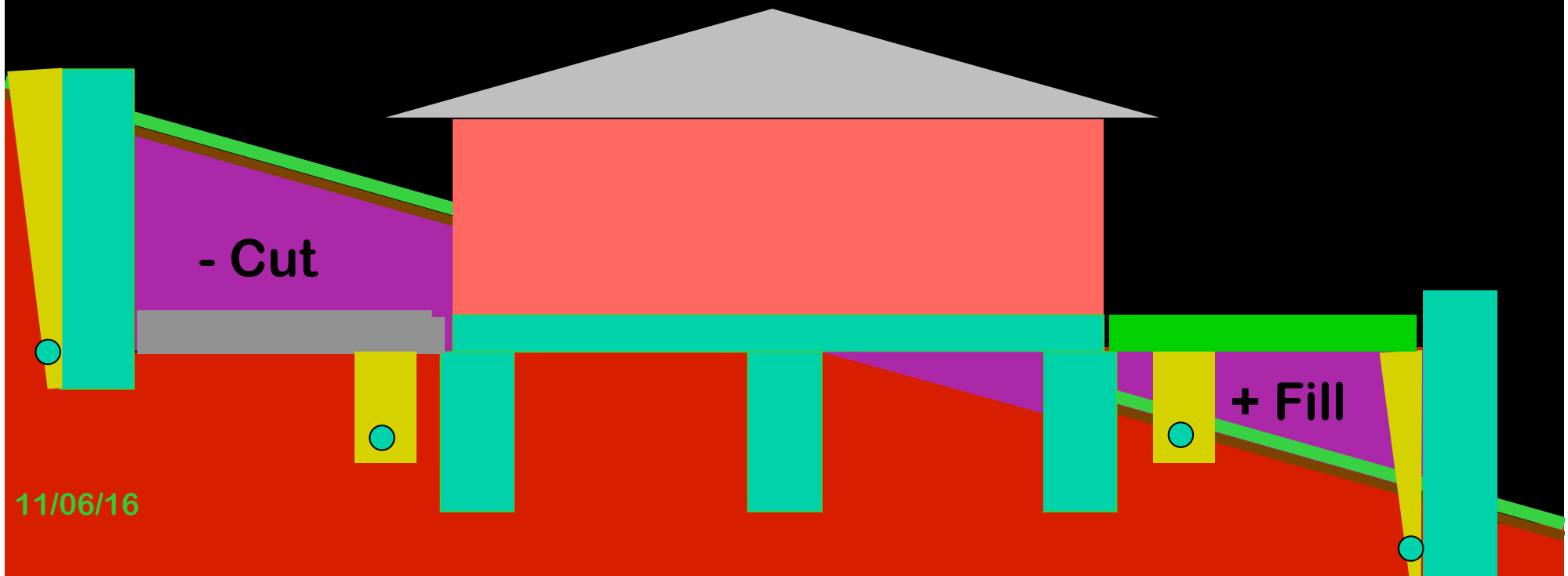
- Cut

+ 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



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# Cut and Fill

Check all your quantities  
first and determine the level

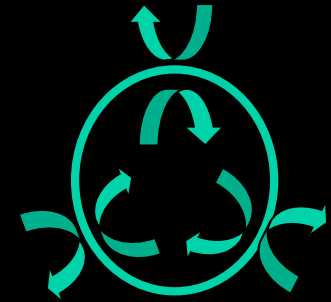


Or decide the level and  
determine the position of the  
building

- Cut

+ Fill

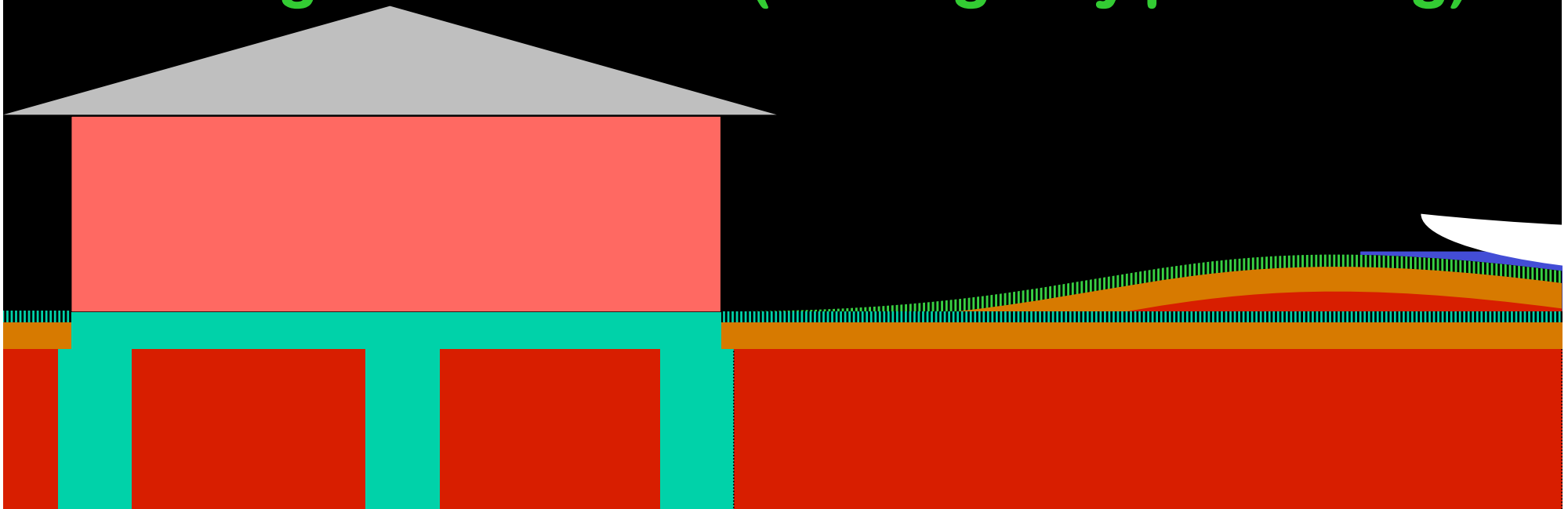
# Excavation Arisings



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

Use it in intelligent landscape modelling

Including flood defence (Env. Agency permitting)



# Hollyrood Scottish Parliament

- Intelligent reuse of excavated subsoil
- Landscape features: surplus subsoil
- Topsoil and grass



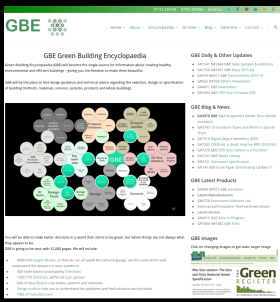
# Environment Agency

- **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**

# 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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# CAP'EM

Cycle Assessment Procedure for Eco-impacts of Materials



# © GBE 2007 - 2016

- **Brian Murphy BSc Dip Arch (Hons+Dist)**
  - Architect by Training
  - Specification Writer by Choice
  - Environmentalist by Actions
- **Greening up my act since 1999**
- **Founded National Green Specification 2001**
- **Launched [www.greenspec.co.uk](http://www.greenspec.co.uk) 2003**
- **Created: GBE at [www.greenbuildingencyclopaedia.uk](http://www.greenbuildingencyclopaedia.uk) 2015**
- **E [BrianSpecMan@aol.com](mailto:BrianSpecMan@aol.com)**
- **Twitter: <http://twitter.com/brianspecman>**
- **Facebook: <http://www.facebook.com/brianspecman>**
- **LinkedIn:**