Design to help Reduce Waste

Easy steps to reduce your share of the 120 m tonnes of construction and demolition and excavation waste each year

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  - the whole presentation all of the hidden slides
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Design generates waste

- Waste reduction is not a site issue
  - It is a Design Issue
- It becomes a site issue
  - if is was not seen as a Design issue
- Join in now or
  - D&B takes another % of UK procurement

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Chinese Jigsaw Puzzles

- Arup Associates (Multi discipline practice)
- Peterborough Sugar Beet Factory
- Office Pavilion
- Suspended ceiling: Bespoke
- Designed to take out and reinstall like a Chinese jigsaw puzzle

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British Sugar

- Q How do we get into ceiling void
- A For us to know and for you to find out
- Fist through the first and rip the rest out
- Vowed never to commission Arup again
  - Quite right.
  - And now use Technicians

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Facts and Figures

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SITE^{wise} II Waste Campaign

- Environment Agency (Anglian)
- Breakfast meetings
- 200+ Pre-construction Professionals
- Waste is not a key issue
- Scored 8th out of 12 issues

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Some easy wins

- Design to standard sizes
- Design to reduce off-cut waste
- Design for on and off site reuse
- Design for on and off site recycling
- Design for maintainability, adaptability & flexibility
- Design for deconstruction and reuse
- Design spares storage for maintenance
- Design for in use waste management

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Serendipity?

- Design for Easy of Assembly
- Lends itself to
- Design for Deconstruction
- But Architects are not very interested in construction nor deconstruction
- The RIBA curriculum does not address it very well
- RIBA external course assessors frown at too much technology

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Relearn some waste statistics

- 410m tonnes/year materials to UK CI
- 120m tonnes/year wasted by UK CI
- 30m tonnes is materials off-cuts
- 24m tonnes/year (24%) is packaging
- 23.7m tonnes/year soil & rock
- 10m is temporary materials
- 10m tonnes/year over ordered never needed £1.5bn/annum (EA 2007)

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Materials consumed by UKCI 2015

- 576 Mt Materials
- 98 Mt Concrete
- 9.2 Mt Timber
- 6 Mt Bricks
- 3.9 Mt Metals
- 1.4 Mt Plastics
- 1.4 Mt Glass

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Water Consumption UK CI

- Demolition: 45 tonnes/100m2
- Refurb-fit-out: 22 tonnes/100 m2
- Mixed: 18 tonnes/100 m2
- Newbuild: 16 tonnes/100 m2
- Civil/Engineering/Groundworks:
- 12 tonnes/100 m2

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Re-used materials UK 2007

- Iron & Steel: 54,000 tonnes
- Wood: 390,000 tonnes
- Brick: 850,000 tonnes
- Stone: 625,000 tonnes
- Declined 25% compared to 1998

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Legislation improved stats

- 400m tonnes/year materials to UK CI 2004
- 576m tonnes/year materials to UK CI 2015
- 110m tonnes/year wasted by UK CI pre 2004
- 78m tonnes/year wasted by UK CI at best
- With SWMP Regulations in place
- Then legislation dropped:
- 120m tonnes/year wasted by UK CI 2014

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Latest Waste Statistics

- 576m tonnes/year materials to UK CI 2015
- 120m tonnes/year wasted by UK CI 2014
- =59% of total UK waste
- =30% construction pre-tax profit
- <1% 0.75 Mt Hazardous waste
- 54% 65 Mt Inert Excavation waste
- 5% 6 Mt non-hazardous to landfill
- 41% 45 Mt non-hazardous recycled or recovered (compost or energy from waste)

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Waste by UKCI Sector m3/£100k

Use	Refurb. & Fit-out	New Build
Commercial:	12	22
Retail:	10	16
Office:	16	14
Residential:	10	15
Education:	7	15
Healthcare:	16	14
Leisure:	12	14
Public Buildings:	11	13
Industrial:	11	13

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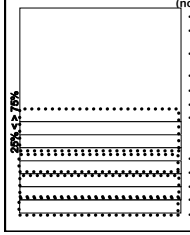
Over ordered never needed Lost, stolen and reordered

(not to scale)



- Required for the design
- QS inaccurate take off +/-10%
  Requires remeasure by contractor
- SMM7 Wastage factor 5-20%
  33% is off-cuts, 3% is damage
- ▲ Over-order safety margins x%
- Minimum order quantities +++
- Call-off extra % JIC Just in case
- Merchant delivers % more than required
  - in the hope nobody is checking,
  - invoices accordingly
- ▼ Lost on site
- .....Stolen from site for PJs 20%
- Reorderd to replace lost or stolen
- .....Damage & Poor quality work 3%
- .....Spares for on going maintenance

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Relearn some waste statistics

- UK CI generates hazardous waste:
- 5m tonnes/year 50% is landfilled
  - (New rules this grows to 7m tonnes/year)
- 21% of all UK Hazardous waste
- Of 240 hazardous waste landfill sites only 10 (2004) signed up to new rules
- None in London, Scotland and Wales
- Sites in MK, (Swindon), Teeside & Pboro
- 250 material reclassified as hazardous

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Relearn some waste statistics

- There is a fly-tipping incident every 35 seconds in the UK
- 1 m Fly-tipping incidents in 2004
- 6000 20t trucks within M25 in 15 months
- CI: 30% of fly tipping incidents (2004/5)
- £44m/year clean up costs
- £50,000 fines and 5 year prison possible

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Relearn some waste statistics

- Packaging waste can vary between 5% and 50% (24% average) of waste stream depending on construction method
- 100% Glazed façade = 50%
- Domestic Brick & Pitch = 5%

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Common Waste Causes 1

- Offcuts: 33.2%
- Recyclable packaging: 18.7%
- Excess deliveries 18%
- Temporary materials: 10.3%
- Reusable packaging: 14.4%
- Site Office and Canteen: 4.1%
- Damaged through methods of work: 3.2%
- Unsuitable storage: 1%

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Excess Deliveries 18%

Concrete tiles No Architectural Salvage value but restock able and usable

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Damage by methods of work 3.2% 25

Specify Cast-in Lifting eyes sockets; require protection, consider repair before condemning

Demolition waste % by volume

(BRE limited studies)

- Concrete: 52.6%
- Ceramics: 22.5%
- Furniture 16.6%
- Timber 3.4%
- Miscellaneous 1.9%
- Metal 1.4%
- Plastic 1.3%
- Electrical Goods 0.3%

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Demolition reuse and recycling potential

(BRE limited studies)

- Reusable 40.6%
- Reusable but soiled 1.2%
- Recycleable 27.3%
- Energy from waste 3.4%
- Inert waste to landfill 17% 16mt
- Mixed waste to landfill 10.4% 9mt

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Building Refurbishment Waste

- Previously insulated with High ODP (Ozone Depletion Potential) insulation boards made until 2004
- Why remove existing insulation?
  - To add more room, charge more rent,
  - To increase fuel bills
- Insulation is damaged and cut into pieces to try to fill skip efficiently
- What good does it do in a landfill site?
- Ozone Depletion Potential realised by cutting cells and releasing gases
- This is classified as Hazardous waste in a mixed skip

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BREEAM v Ska

- Different Priorities
- BREEAM: Business as Usual
  - K40 reuse
- Ska: make a difference
  - K40, K41, M10, M40, M50, M51 reuse

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Waste Hierarchy

Another GBE CPD file to download
See http://www.GreenBuildingEncyclopaedia.uk/shop 33

Waste Hierarchy
official definition & goal

Effort

Reduce
Reuse
Recycle
Recover

More

Less 34

- Jack Johnson
- 3 its a magic number
- 2 x 3 = 6
- 3 x 6 = 18
- 18th letter in the alphabet is R
- R x 3
- Reduce Reuse Recycle
- http://www.youtube.com/watch?v=uSM2riAEX4U

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Ideal Waste Hierarchy

- Reduce
  - Reduce demand, reduce waste
- Reuse
  - As originally intended
- Recycle
  - In a new format
- Recover
  - materials or energy from waste

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Reduce:
Modular design wastes less
Allows reuse readily

- Walter 'Segal Method'
- Whole component used full size no cutting

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Reclaimed repaired
Reused and reusable

Recycled steel frames
Redundant bolt holes
Blast clean and prime/paint

BedZED Beddington Sutton Architect: Bill Dunster
Reclaim: BioRegional ReCLAIMED © NGS 38

BedZED Beddington Sutton Architect: Bill Dunster
Reclaim: BioRegional ReCLAIMED © NGS 39

Reused wood better than new

BedZED Beddington Sutton Architect: Dr Bill Dunster,
Reclaim: BioRegional ReCLAIMED © NGS 40

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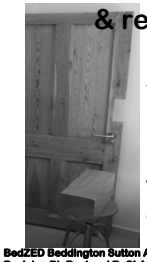
Reclaimed, repaired & reused Doors



Reusing Doors
Visible Patch repairs
If you don't like them French polish or paint them

BedZED Beddington Sutton Architect: Bill Dunster
Reclaim: BioRegional ReCLAIMED © NGS 42

BedZED Beddington Sutton Architect: Bill Dunster
Reclaim: BioRegional ReCLAIMED © Nicole Lazarus 43

Recycle: Glass sand for bedding

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Waste Hierarchy
The reality

Effort

Reduce

Less

Reuse & Recycle

Recover

Reject

More

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Waste Hierarchy
new definition

Rethink, Re-educate, Resolve, Refocus, Resource, Relate, Research, Refer, Refresh, Rename, Regard, Revalue, Remeasure, Reprogramme, Replan, Reconsider, Refuse, Reject, Return, Redesign, Regularise, Rehearse, Rationalise, Remediate, Reduce, Reserve, ReSpec, Register, Reuse, Reclaim, Repair, Retain, Remind, Recycle, Recover, Record, Report, Reward, Review, Revise, Refine, Restart

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This house only uses reject floor boards from too high a spec
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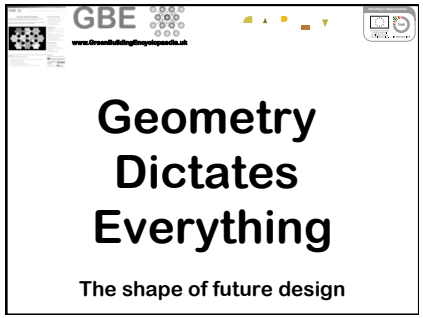
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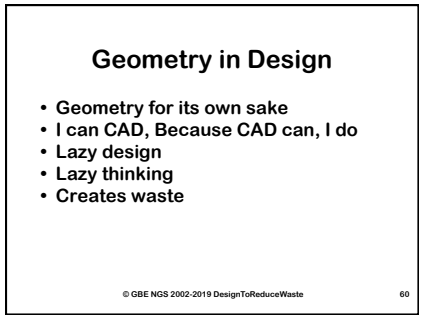
Geometry Dictates Everything
The shape of future design


Geometry in Design
• Geometry for its own sake
• I can CAD, Because CAD can, I do
• Lazy design
• Lazy thinking
• Creates waste
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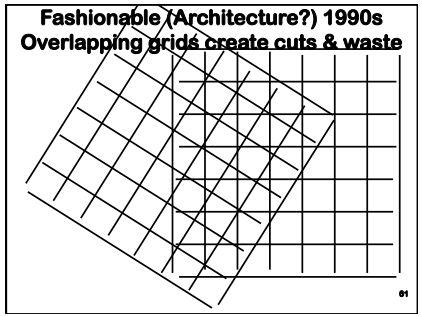
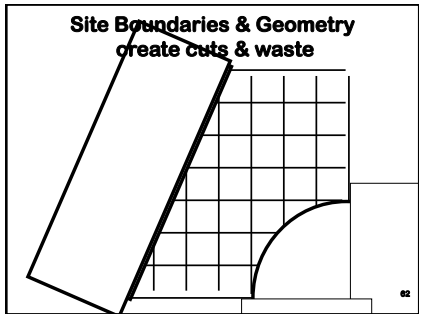

Fashionable (Architecture?) 1990s
Overlapping grids create cuts & waste
61


Site Boundaries & Geometry
create cuts & waste
62

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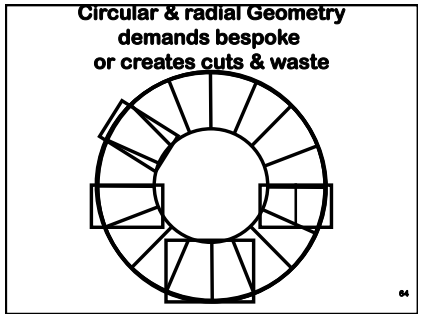
Circular & radial Geometry
demands bespoke
or creates cuts & waste
64

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Design Dictates Waste
• Lazy design
• Labour intensive construction
• Cutting edge blocks generate waste
• Embodied energy in wasted materials
• Opportunity to object to quality
• Condemn materials to skip
• Delay programme
• Anger the tradesman
• Quantity Surveyor: think waste & labour
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Design Avoids Waste

- Setting out not straightforward
- Few cut bricks: less waste
- Labour simplified
- Looks expensive but cheap to lay
- Assumptions made about relative costs
- Value Engineering for Quantity Surveyors:
- Think resource efficiency and simple construction

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Construction/Deconsruction

- Margins hold it all together
- To prevent early failure
- Contain sub bases and beddings
- Prevent sand bedding trickling out
- Permits dry sand bedding & jointing
- Enables reclaim and reuse of materials

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Defective Design

- Defective Design
- Exposure to worse conditions
- Ineffective components
- Diminished/ing performance
- Leads to early failure:
  - Refurbishment, removal, rejection, reordering, remanufacture, replacement, removal, relaying

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Reuse of what you find on site

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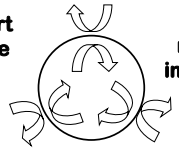
Site Autonomy

No export from site

No materials imported to site



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Cut and Fill

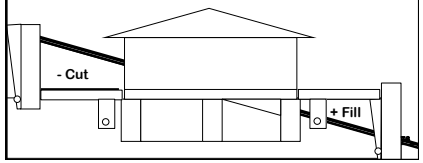
In principle a simple idea

- 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

- Cut

+ Fill

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Cut and Fill Software

- PDS by Causeway (formerly EXL)
- utilises existing contour maps to create a 3D build-up of the landscape
- Then the required model of levels/ grades is added
- It calculates the total volumes in/out.
- This can be varied to give an overall [near] zero outcome.
- (Depending on planning permission for height/depth)

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Application:

- Although it is primarily aimed at highways and large scale developments it can, no doubt, be adapted for smaller scale use.
- It does require a site survey –
- obviously the more comprehensive the survey the better
- because the program interpolates between levels.

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Outputs

- Output is in the usual myriad forms:
- traditional profiles,
- export values to Excel, etc.
- AutoCAD can be used to import/export plans
- PDS can be combined with Windes to calculate, and eventually draw, drainage systems.

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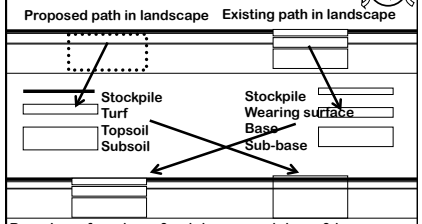
Rearranging pathways



Recycle surface, base & sub-base as sub-base & base add new wearing surface

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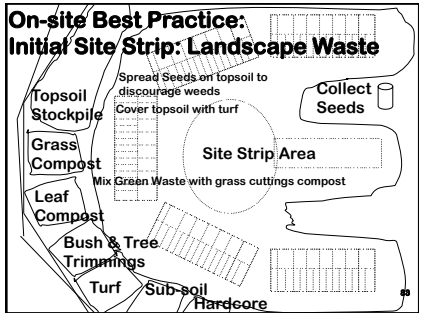
On-site Best Practice: Initial Site Strip: Landscape Waste



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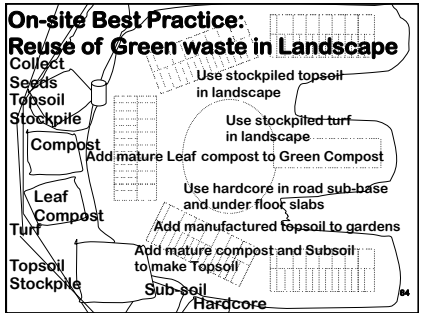
On-site Best Practice: Reuse of Green waste in Landscape



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Topsoil & Subsoil Stockpile on site

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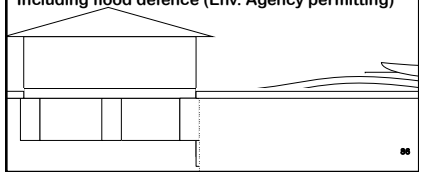
Excavation Arisings

All excavated subsoil materials to be reused on site rather than landfilled
Use it in intelligent landscape modelling
Including flood defence (Env. Agency permitting)



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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

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Use found materials

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

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Rubble Walls

Random sizes, natural look, lime mortar, sheltering roof

89

Roundwood: trees from site

No ground contact, anti-splash height & floor, air movement, places for nature
Layered construction easy deconstruction

Pembrokeshire traditional Hedge Bank

Rubble
Soil
Turf
Rainwater

Back to nature very rapidly

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Pembrokeshire hedge bank

Random rubble & slate outer leaves, wild turf mortar, subsoil cavity fill, topsoil2 & wild turf/hedge plants on top, crevices for nature, rain rejuvenates in weeks

Brown Roofs

Creekside Visitors Centre Deptford London: Ballast for waterproof membrane

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Brown Roofs

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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.

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Brownfield Landscape
Creekside Visitors Centre
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Wild Flowers & Meadow Grass
Neglected landscape nature takes over Listed Grade I barn
98

Greenwich Millennium Village Phase 2b
- Reclaimed Polluted Gasworks site
- 900 mm. polluted soil removed to landfill
- GPM capping 900 mm. down
- 900 mm. imported sub and topsoil
- Passive ventilation boards at ground level below ground floor

Architect: Proctor Matthews
Specification Consultant: Brian Murphy
99

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

100

Ocean Terminal Leith Edinburgh
- Reclamation of derelict harbour site
- Part of regeneration of area
- Polluted landfill capped by building

Conran Design Partnership
Brian Murphy Specification Consultant
101

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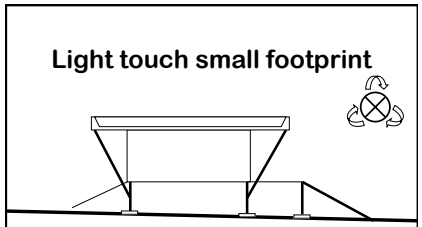
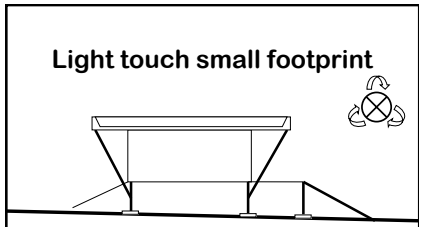
Resource Efficiency: Foundations



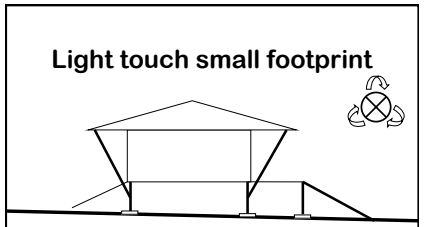
Light touch small footprint

No excavation
Paving slab foundations
Add water for ballast against wind uplift (top up in summer)
Thermal Mass, solar protection and evaporation cooling
103



Light touch small footprint

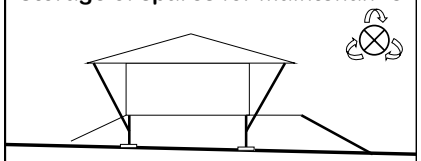
No excavation
Paving slab foundations
Add living roofs for ballast against wind uplift
Thermal mass, solar protection and acoustic insulation
104



Light touch small footprint

No excavation
Paving slab foundations
+ve wind pressure on roof
105

Storage of spares for maintenance



Space under building for storage
Space for flood water
Space for nature
Space for children`s play

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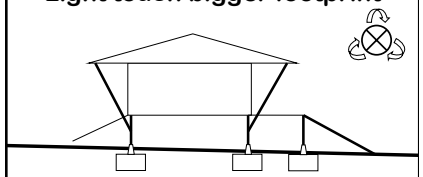
Light touch bigger footprint



Shallow excavation
Pad foundations
+ve wind pressure on roof

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EcoConcrete

- Reduced OPC Ordinary Portland Cement content (reduced CO^2 production) ready blended with % OPC
  - 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.)
  - Manufactured Aggregate
    - (CO2 + H2O + particle = Calcium Carbonate) Carbon8Systems
- Mains drinking water supply

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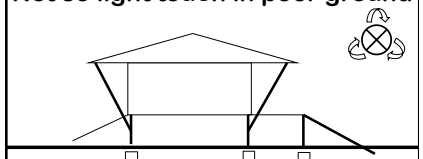
Driven Piled Foundations Minimise Arisings

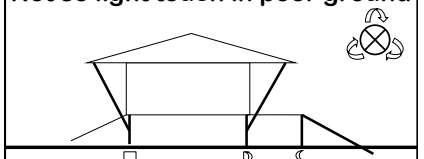
Not so light touch in poor ground



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

111

Not so light touch in poor ground



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

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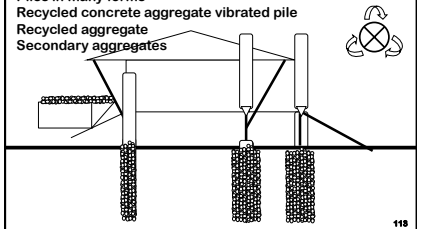
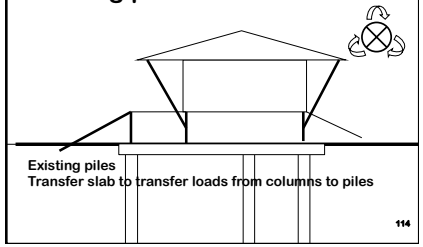
Not so light touch in poor ground

Piles in many forms
Recycled concrete aggregate vibrated pile
Recycled aggregate
Secondary aggregates



113

Existing piles & Transfer slabs



Existing piles
Transfer slab to transfer loads from columns to piles

114

GBE
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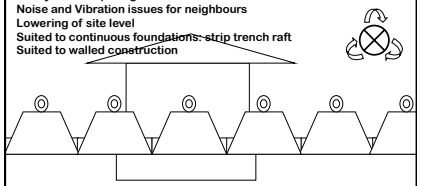
Dynamic consolidation improves ground & simplifies foundations

Dynamic Consolidation

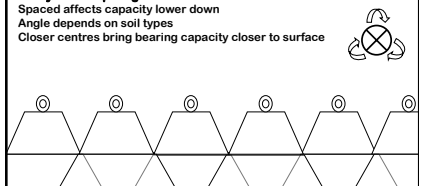
Dynamic Consolidation of subsoil to improve load bearing capacity
Heavy touch in poor ground
Noise and Vibration issues for neighbours
Lowering of site level
Suited to continuous foundations: strip trench raft
Suited to walled construction



117

Dynamic Consolidation

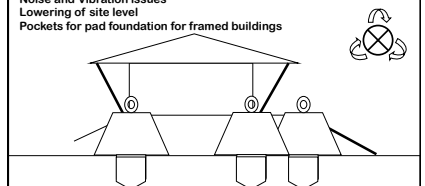
Dynamic Consolidation of subsoil to improve load bearing capacity
Heavy touch in poor ground
Spaced affects capacity lower down
Angle depends on soil types
Closer centres bring bearing capacity closer to surface



118

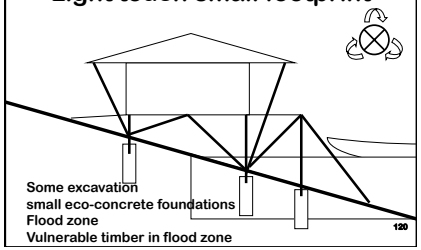
Heavy touch in poor ground

Dynamic Consolidation of subsoil to improve load bearing capacity
Noise and Vibration issues
Lowering of site level
Pockets for pad foundation for framed buildings



119

Light touch small footprint



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

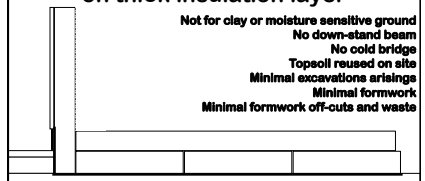
120

Resource Efficiency: Concrete Ground Floor Slab Formwork

Layered Construction
Simplifies Details

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



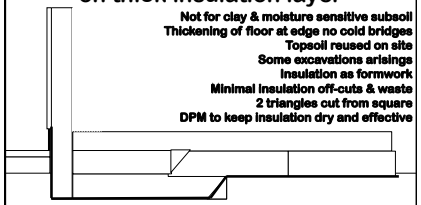
Some Structural Engineer's not happy to do this

122

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



Some Structural Engineer's happier to do this

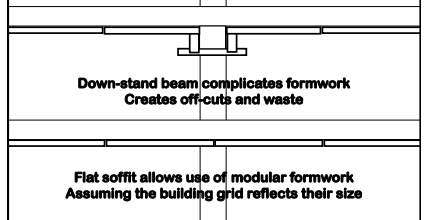
123

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

124

Insitu concrete floor slab formwork

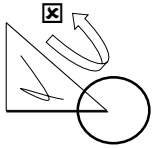


Down-stand beam complicates formwork
Creates off-cuts and waste

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

125

Resource Efficiency: Return Defects & Protection



Reject & Return Defective Materials

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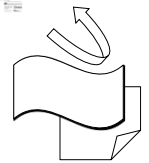

Return Protective & Packaging Materials

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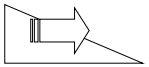
Reduce Demand on materials



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Resource Efficiency: Masonry

Resource Efficiency

- Design for Deconstruction
- Consider: Fixings & Fasteners
- Avoid: adhesives
- Lime based mortar allows reclamation of the bricks at end of building life

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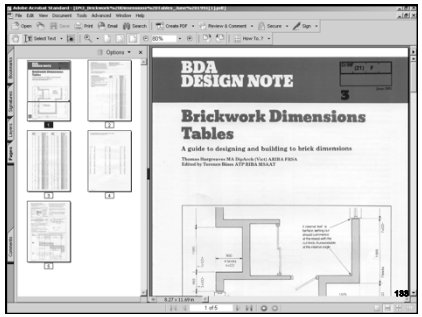


Elizabeth Fry Building UEA

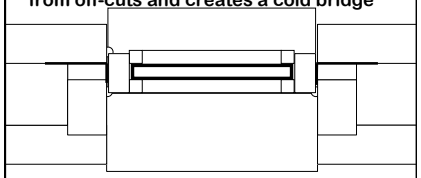
Was one of the most energy efficient buildings in the UK
Also resource efficient co-ordinated design little cutting waste

134

Resource Efficiency: Masonry at openings

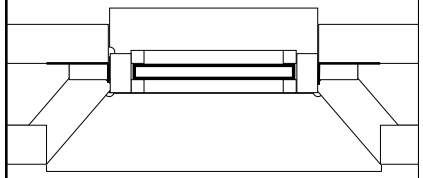
Openings in walls: Plan View

- Block inner leaf return generates waste from off-cuts and creates a cold bridge



137

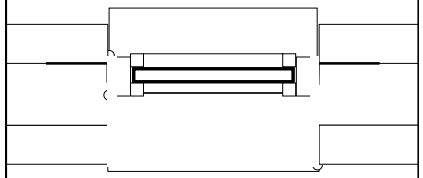
Maximise light penetration
Minimise glare
Generates waste off cuts



138

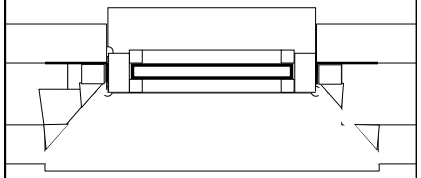
Openings in walls: Plan view

- Omit inner leaf returns: close cavity with window box
- Install window in window box



139

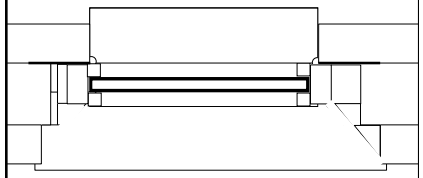
Maximise light penetration
Minimise glare
Generates waste off cuts



Reduce off-cut waste in blockwork

140

Maximise light penetration
Minimise glare
Generates waste off cuts

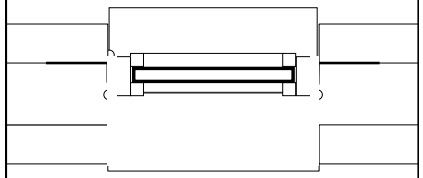


Reduce off-cut waste in blockwork

141

Openings in walls: Plan view

- Omit inner leaf returns: close cavity with window box
- Install window in window box



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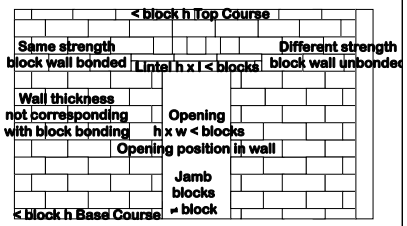
142

No Design: Offcuts 33%+



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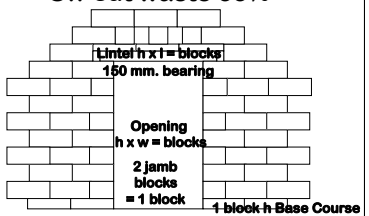
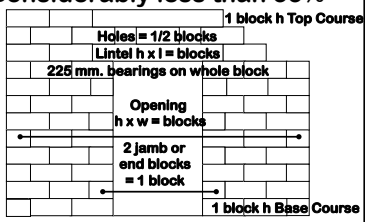
144

Off-cut waste 33%



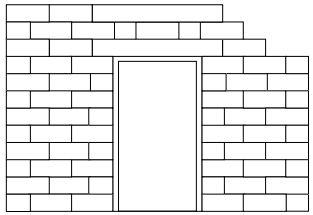
145

Modular design: considerably less than 33%



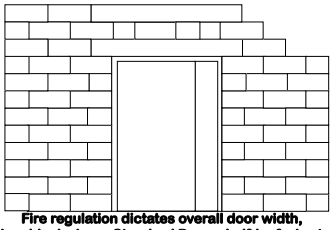
146

Doorsets to fit openings



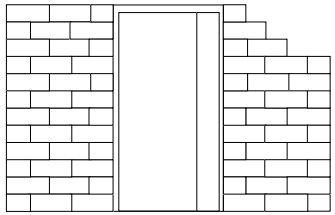
Services apertures half block size 148

Doorsets to fit openings



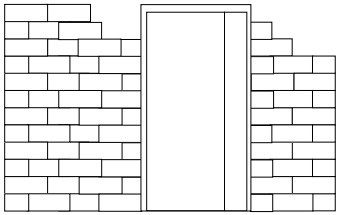
Fire regulation dictates overall door width,
Opening: block sizes, Standard Door + half leaf: size to suit 149

Doorsets to fit floor heights



No lintels, no cutting no waste 150

Blocks cut short in wall



Irregular purpend or block alignment 151

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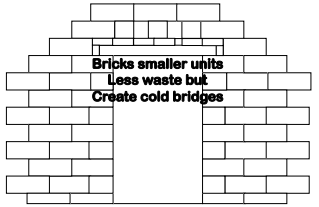
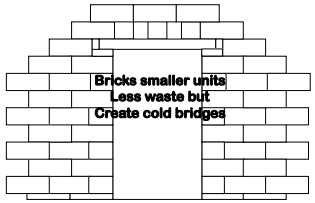
Resource Efficiency v or & Energy Efficiency

Change of material: destroys integrity



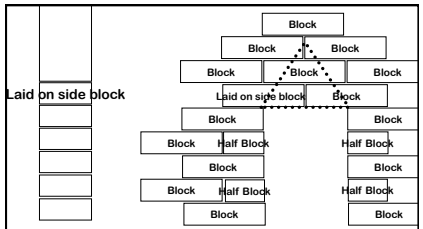
153

Cold Bridges: Inconsistent U value



154

Attempting to reduce waste: creating cold bridges
Cold bridge reducing ties won' t make up for:
brick inner leaf and brick padstones for lintels
Omitting jamb returns reduces waste and cold bridges 155



Concrete blocks forming lintel in walls over opening of max 440 mm.
No lintel, no cutting, no waste 157

© GBE NGS Brian Murphy 2002-2019

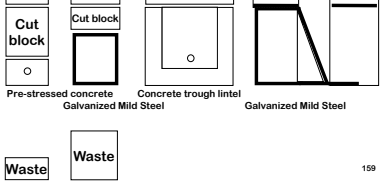
Minimise Waste

- Co-ordinate block course and lintel heights to minimise waste from cut blocks
- 215 mm. bearings
- Design openings to be block and half block sized

158

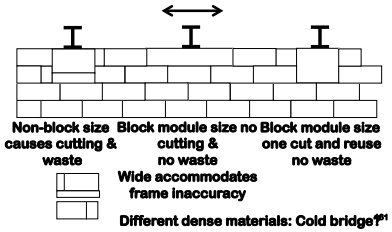
Lintels in blockwork walls

Avoid non-block height lintels
Generating cut blocks & waste



159

Padstones



Non-block size causes cutting & waste

Block module size no cutting & no waste

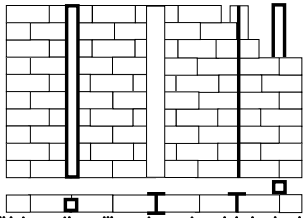
Wide accommodates frame inaccuracy

Block module size one cut and reuse no waste

Different dense materials: Cold bridge?

161

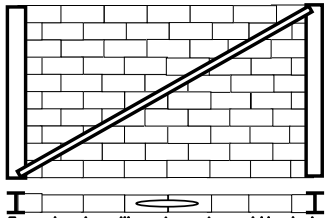
Wind or Stability Posts



Wall interruption will create waste: minimise by design
Different dense materials: Cold bridge? Airtightness?

162

Lateral Bracing

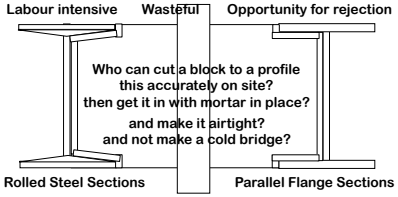


Frame bracing will create waste: avoid by design
Different dense materials: Cold bridge? Airtightness?

163

Blockwork / Steel abutment

Labour intensive | Wasteful | Opportunity for rejection



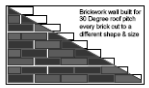
Rolled Steel Sections | Parallel Flange Sections

164

Roof Pitch!

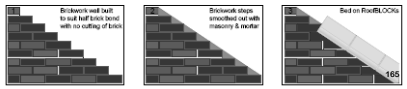
Working smarter with RoofBLOCK

RoofBLOCK PRODUCTIVITY SAVINGS BUILDING GABLE WALLS



To eliminate the time consuming cutting of brick to match the roof slope, build the gable wall to follow the natural rake of brickwork, a pitch of 1:1½ (i.e. 33.7°).

The brick deep recess in the base of the RoofBLOCK will hide the ragged top of the brickwork slope whilst left over blockwork & mortar can be used-up to smooth out the brickwork steps before laying RoofBLOCKs up the gables.

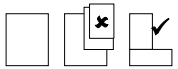


165

Resource Efficiency: Timber

Reduce Demand

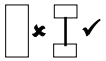
- Don't over design structure
- Except if long design life demands it
- Don't oversize
- Don't cut section from solid if compound is possible

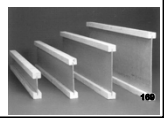


168

Reduce Demand

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

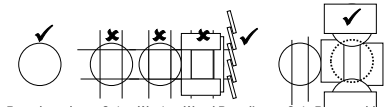




169

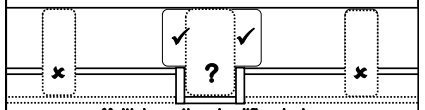
Reduce Demand

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



170

Joists/Beams & Partitions

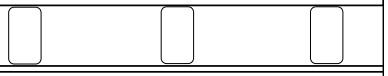


Multiple section simplifies design

Different section complicates detail
Creates off-cuts and waste
Standardise appearance overdesign

172

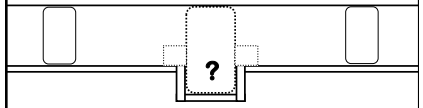
Joists



Multiple section simplifies design

173

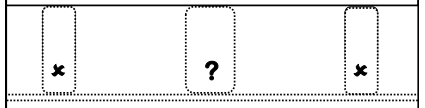
Joists/Beams & Partitions



Different section complicates detail
Creates off-cuts and waste
Changes appearance below

174

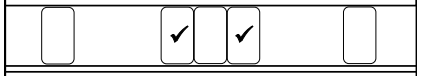
Joists/Beams & Partitions



Standardising size leads to over-design of many for the one

175

Joists/Beams & Partitions



Multiple section simplifies design

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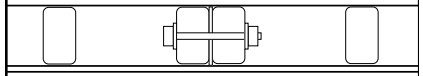
176

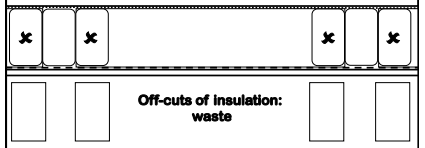
Floor Joists/Beams & Partitions



Multiple section with flitch plate of steel bolted together

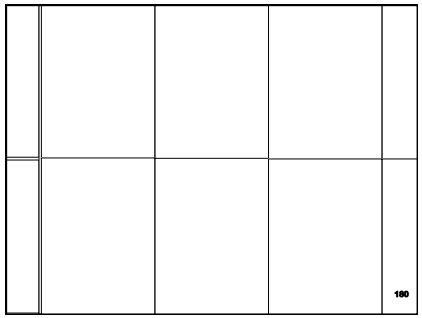
177

Strength v U Value in external wall



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

179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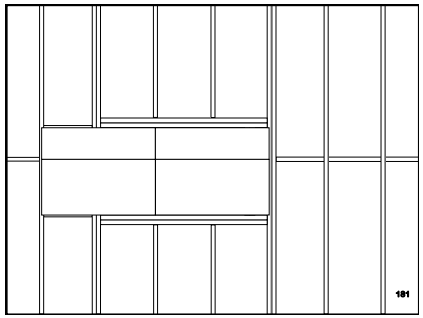
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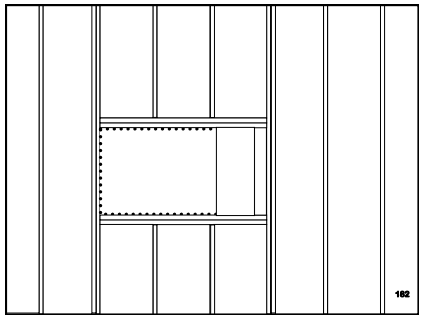
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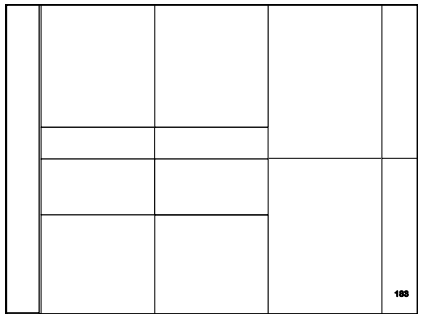
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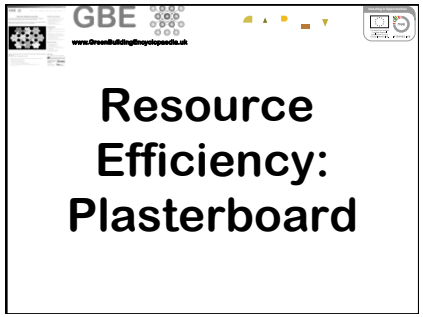
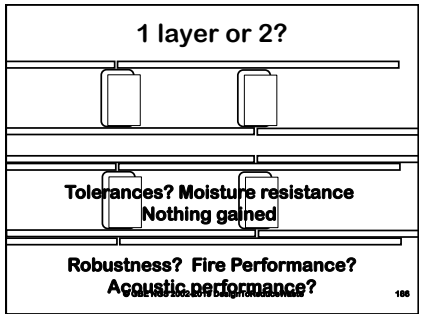
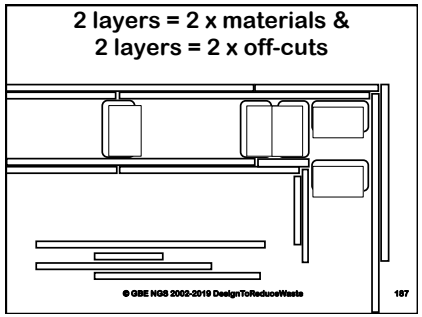

GBE
Resource Efficiency: Plasterboard


1 layer or 2?
Tolerances? Moisture resistance
Nothing gained
Robustness? Fire Performance?
Acoustic performance?
186


2 layers = 2 x materials &
2 layers = 2 x off-cuts
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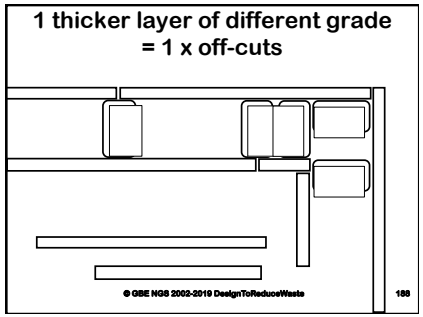
187


1 thicker layer of different grade
= 1 x off-cuts
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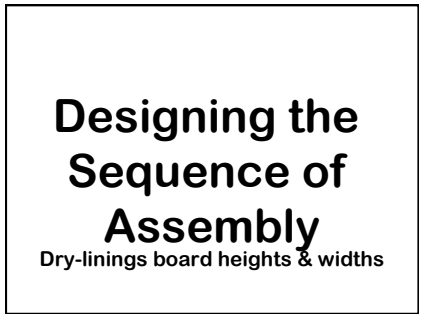
Designing the Sequence of Assembly
Dry-linings board heights & widths

Design dictates Sequence & numbers of visits

- The details at the abutments dictate the sequence of assembly
- Whether the designer likes it, admits it or not
- Construction & Structure: foundations to roof
- Consider: wet trades: first, dry: second
- Consider: working top down to minimise damage of floors by following trades
- Consider: working from the room extremity back towards the exit door

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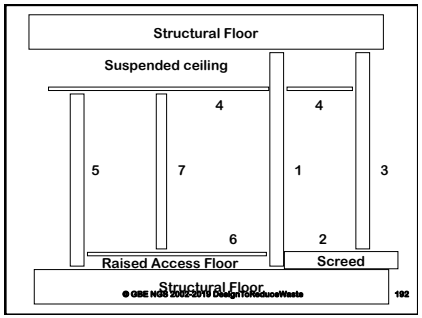

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Design details create waste

- Many heights of partitions and linings
- Creates demand for different height boards
- 1 maker provide an off-cut take-back scheme (BG but not comprehensive)
- Others provide purpose made boards cut to height (if the job is big enough)
- Others cut board to size (F)
- How many sizes does your job need?

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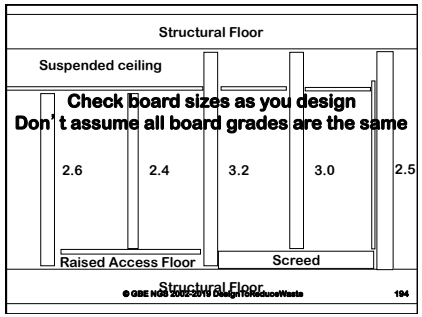

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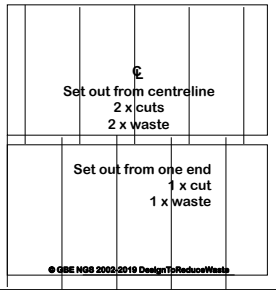

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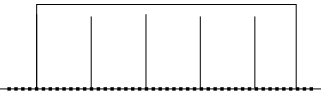
Appropriate Materials to application

Dry-linings and Flood risk

Board layout & Flood Water



- All boards partly damaged
- All boards removed and replaced

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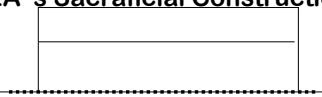
Board layout & Flood Water EA's Sacraficial Construction



- Lowest board(s) damaged
- Lowest board(s) removed and replaced
- Why use plasterboard in flood prone areas?
- Cement Render is better in flood prone places

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Reuse of off-cuts

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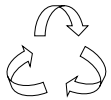

Recycle
Materials
on-site

Reuse spare
materials
on-site & in use

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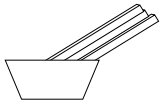

Segregate waste
local to
point of generation
to enable reuse
on-site or offsite
And even on-site again

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Reuse Off-cuts

- Deliver off-cuts with cassette panels
- Reuse off-cuts as props
- Don't cut studs to make props
- Use joist off-cut as strutting in floors
- Use off cuts for local strengthening for sanitaryware and wall furniture

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Redesign to reduce waste

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Avoid Late Design Changes

- Late design changes
- Late instruction
- Late changes
- Incorrect materials being delivered
- Leads to error
- Leads to waste

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Wrong Information

- Late instructions
- Revised design?
- NEDO report 1987
- Quality On Building Sites
- QRE Quality Related Events
- Errors in information or in its delivery
- 50%:50% split Design:Construction

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Late design change

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Late design change

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Off-cuts 33%

- We are familiar with sizing walls to bricks and half brick lengths (but we still don't do it everywhere)
- Internal walls designed to block lengths
- Block sized openings
- coursing to avoid cut blocks
- lintels same size as blocks, no cuts
- Bearing to correspond with block size

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Mad Mad World

- HHP: Nick the Builder has a business taking architects drawings the constructor can't understand and redrawing for them
- Lovells: They use external CAD Jockeys the drawings who did not acknowledge brick sizes, when asked to correct it, told that is extra money.

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Mad Mad World

- AJ August 2010 Article
- Architects permit reuse of off-cut bricks in brickwork to avoid waste
- Instead of designing the brickwork to brick sizes in the first place
- They might regret their decision

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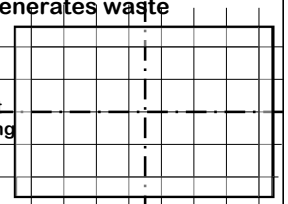
Random Sizing: generates waste

- Random dims
- Centred setting out
- Tile spacing
- Cut edges
- Waste



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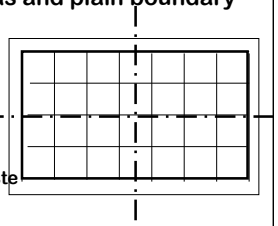
Grid areas and plain boundary

- Random dim rooms
- Centred setting out
- Tile spacing
- No cut edges
- Reduced waste



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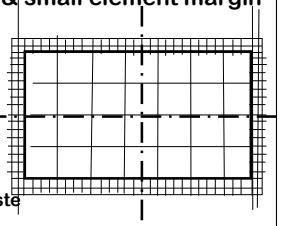
Grid areas & small element margin

- Random dim rooms
- Centred setting out
- Tile spacing
- Smaller tiles
- at perimeter
- Reduced waste



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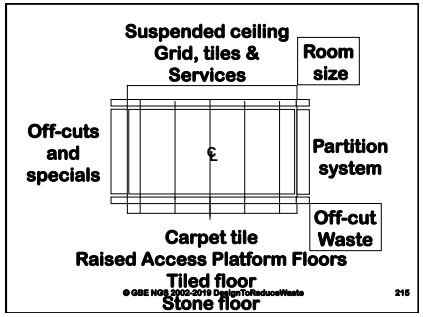

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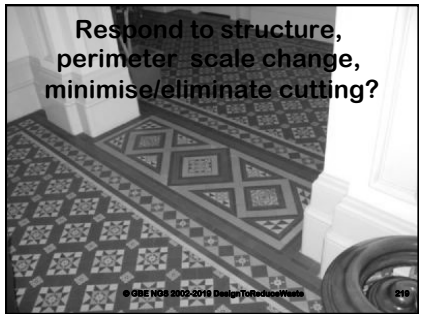

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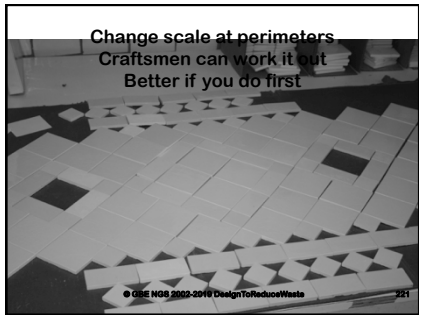
Mosaic infinite adjustment
if boarders permit


Change scale at perimeters
Craftsmen can work it out
Better if you do first
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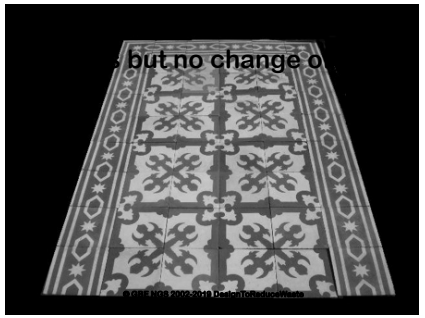
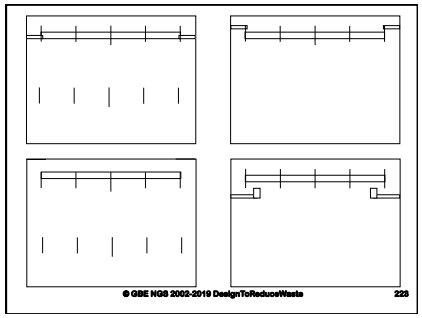

but no change o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Designed whole tiles with margin
Tiled with margin but tiles cut at margin

Designed whole tiles with margin
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Tiled with margin but tiles cut at edge
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Non-rectilinear buildings make waste
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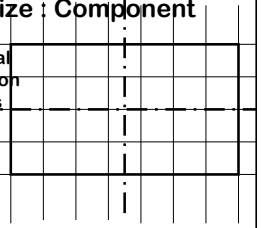
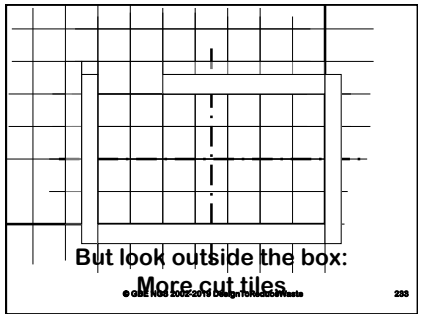
Design Avoids Waste

- Setting out: Not straight forward
- Few cut components: little waste
- Labour simplified
- Looks expensive: cheap to lay
- Assumptions made about relative costs
- Quality Surveyor: think resource efficiency & simple construction

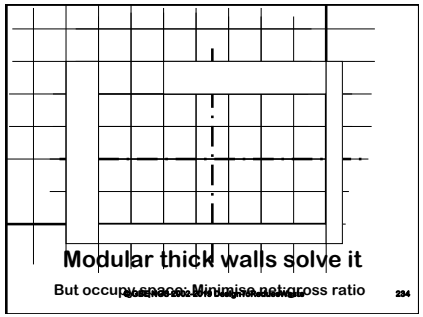
Coordination Reduces Waste Room Size : Component

- Dimensional co-ordination
- Room sizes match Tile modules
- No waste



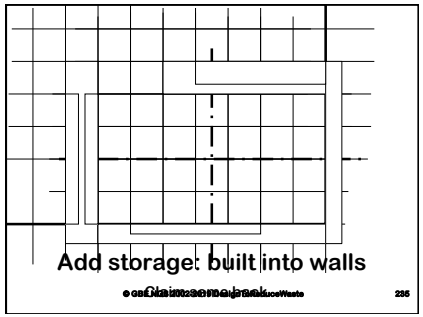


But look outside the box: More cut tiles



Modular thick walls solve it

But occupy space: Minimise net:gross ratio

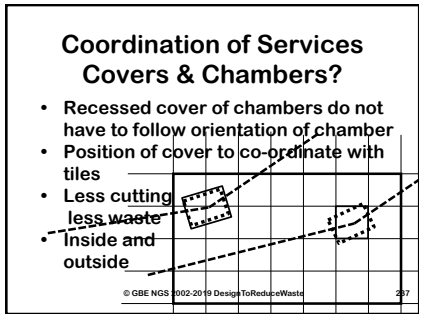


Add storage: built into walls

Claim some back

Coordination of Services Covers & Chambers?

- Recessed cover of chambers do not have to follow orientation of chamber
- Position of cover to co-ordinate with tiles
- Less cutting less waste
- Inside and outside



Design to minimise waste

- We are familiar with sizing walls to bricks and half brick lengths externally
- And now also blocks internally
- What about:
- 8 x 4 Panels in modules
- Lengths of structural members

Off-cuts 33%

- Boards 8 x 4 Panels in modules
- Timber sections: Off-cuts for noggins
- Design structural members at size they are manufactured
- Make toilet cubicles core board and plastic laminate sheet sizes

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Schools

- Money available based on set room sizes
- Does not allow for size variation to minimise waste from off cuts
- Tries to control costs
- but ends up costing more
- due to high wastage factor

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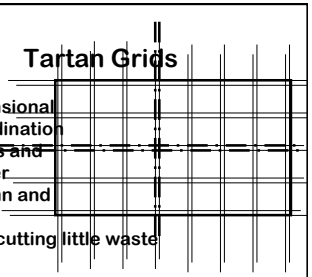
Tartan Grids



- Dimensional co-ordination
- Panels and Spacer
- Column and walls
- More cutting little waste

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Modular designs waste less

- Walter Segal Method
- Whole component used full size no cutting
- Inside and out

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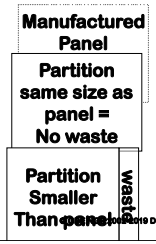
CAT Centre for Alternative Technology 242

Partitions from Panels



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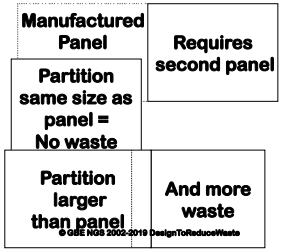
Partitions from Panels



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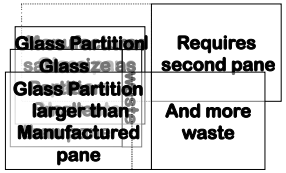
Glass Partitions created from glass panes



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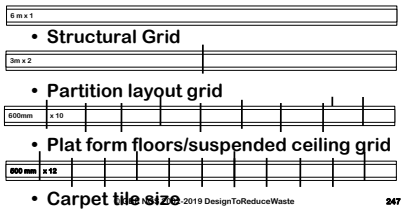
Size is Everything

Co-ordinated?



- Structural Grid
- Partition layout grid
- Plat form floors/suspended ceiling grid
- Carpet tile size

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Design Tools & Calculators

- Flooring REAP FSP ambition,
  - grant application with WRAP
- Size of space
- Size of flooring components
- Design setting out rules
- Minimum order quantities
- Waste %, tonnes, £, EE, EC
- Alternative materials: better %?
- Different setting out rules?
- NGSCALCULATORS

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Optimum fit

- Room Size: 2184 x 3567 mm.
- Flooring product size eg 600 x 600 mm.
- Layout rules: centered/one end/angle
- Perimeter condition: skirting detail
- Offcuts: m2, kg, %, £Waste, EE, EC
- Optimise: find best fit product size
- Reduce waste

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Calculators

- Develop Waste Cost ® lite calculator
- Calculator 1
  - Set room size
  - Trial floor product sizes
  - Trial floor product
- Calculator 2
  - Set floor product sizes
  - Trial room sizes

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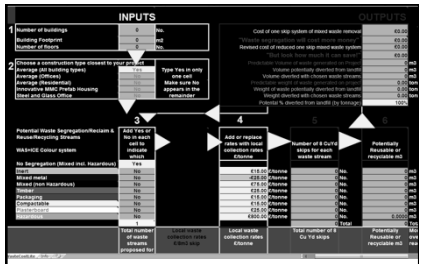
Demonstration

file://localhost/Users/BrianSpecMan/Documents/ASWSDOCS/GREEN/NGSpec/NGSServices/NGSWasteCostLite/WasteCostLite(R)B.xls



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Lazy Architecture

- Simple repetition without differentiation
- No awareness of size
- Cut perimeters
- Wasted materials

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Proactive Architecture

- Need to know the size of stuff
- Need to work with them not at odds
- Look after the edges the middle looks after itself
- Keep it Simple

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I Can CAD, CAD can, So I Do

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Eco Greenwash Architecture

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1000 x 1 or 1 x 1000

- 1000 bespoke sizes and shapes
  - No large scale production runs
  - Every one is handled slightly differently
  - No simple packaging
  - Labelling critical
  - Production assembly and delivery sequence vitally important
- Or 1 size x 1000

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Glass Cutting: Almost Rectangular

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SMM7 Standard Method of Measurement

- All shapes cut for closest rectangle
- All off-cuts are waste
- Accuracy +/-10%
- No concern about waste or site ordering from quantities
- Contractor expected to re-measure

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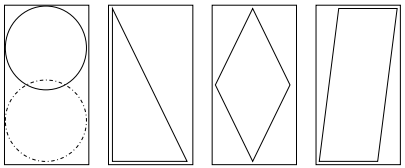
Glass Cutting SMM



If you want a shape you pay for a rectangle,
If the rectangle is paid for, nobody cares about waste

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Consistent glass triangles within each level

Different triangles at almost all levels

No vertical columns

Vast amounts of off cuts on the factory floor

We hope its all recycled in manufacture

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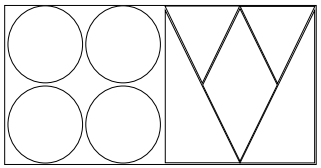
Glass Cutting CADCAM tailoring = Iteration



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CADCAM Tailoring = Iteration

- Maximising the yield from sheets of glass
- Many pieces arranged to get more pieces from smallest glass pane
- Pieces cut from sheet
- Just like a tailor and fabric directionality is important
- Potential conflict with 'Roller Wave Pattern'
- RWP occurs as glass is rolled off zinc float and 'slumps' over supporting rollers

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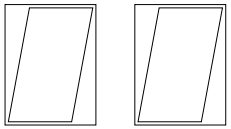
SMM Glass Cutting
simple parallelograms



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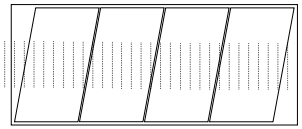
Glass Cutting CADCAM tailoring
with simple parallelograms



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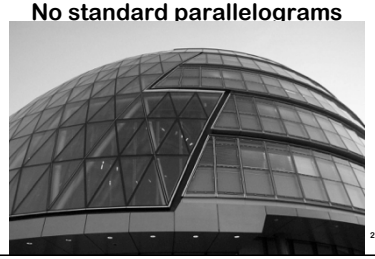
Facetted triangles
consistent on any one level
No standard parallelograms



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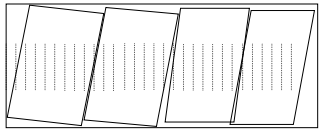
Glass Cutting CADCAM
No pane is the same
efficient tailoring or iteration &
efficient resource use



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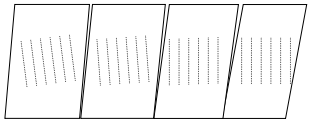
Could lead to
irregular roller wave pattern
when installed



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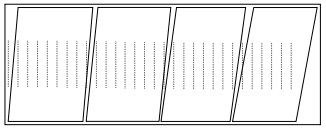
Glass Cutting CADCAM
less efficient tailoring/iteration
regular installed roller wave pattern
Less efficient resource use



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Resource Efficiency

Waste not Want Not

12 m

8m 4m

7m 5m

4m 4m 4m

1m 1m 1m 1m 1m 1m 1m 1m 1m 1m 1m 1m

12 m length chosen as optimum size for 8m. 7m, 5m, 4m, 1 m lengths

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Natural Materials have Natural Variations

Accept them or choose again

Slate production

- For every tonne of Welsh slates created
- 100 tonnes of waste
- Welsh use explosives
- China and Spain cut from solid block
- Cheap slate competes with Welsh unfortunately

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Slate use

- 1 tonne = 100 tonnes of waste at quarry
- Green Spots: 85% rejection at quarry
- More on site:
- We need to accept natural variation in natural materials
- Or choose again

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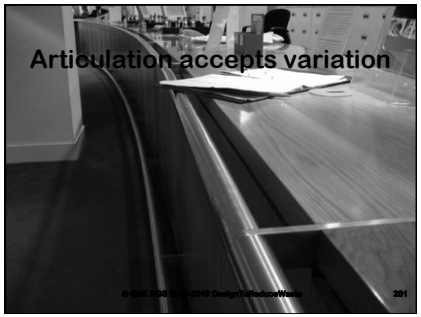

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Production waste stock piles

- 6000 m tonnes of waste stockpiled in UK
- Welsh Colliery spoil mountains
- Part of the Welsh heritage and landscape
- Quarries filled are now being re-mined
- Secondary aggregates used in construction and landscape

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Temporary Materials 10.2%

- Timber formwork for concrete is thrown away
- Why not timber frame?

EcoTech Swaffam Norfolk 283

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Design for Construction & Deconstruction

Fixings and Fastenings
Sequence and Layering

Design for better Assembly

- Locational fixing
- M&T joints
- notching instead of nailing
- Doweled joints
- Screws Pelleted or Plugged

CAT Centre for Alternative Technology 285

Locational Assembly + Gravity
no dimensional limitations
no waste no fixings

Construction Resources Showrooms Southwark London 286

Locational Assembly oversized and compress

- If rafter spacing and insulation size correspond
- No waste
- Do they?

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Choice of fastening techniques

- Using nuts and bolts, screws
- Instead of adhesive, welding and nails.
- Using ballast instead of adhesive: Green roofs or paving

Hedgehog Self-build Brighton Architect: Robin Hiller

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Methods of Assembly and Fastenings to permit deconstruction and reuse of components

Welsh Wild Life Centre, Architect: Niall Phillips: Peter N Roberts

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Methods of Assembly and Fastenings to permit deconstruction and reuse of components

Greenwich Millennium Village and Oxford Science Park Architect: Proctor Matthews

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Brickwork

- Lime mortar is softer, weaker, flexible
- Cement mortar is hard, stronger, rigid
- Lime mortar can be knocked off
- Cement mortar cannot be knocked off
- Lime mortared bricks can be reclaimed
- Cement mortared bricks make hardcore

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Think about Demountability Reconstruction & Reusability

Fixings & Fastenings avoid welding adhesive & nails Use screws & bolts or ballast

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Greenwich Millennium Village Phase 2a

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

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Factory Prefabrication:

- Conditions ensure no deterioration
  - Permit time to set, cure, strengthen
  - Permit time for enhanced performance
  - No mud or cement splashes
  - No rain to spoil
- Use of all the materials supplied
  - Reusing off cuts until all is gone
  - Virtually no waste
- Allows servicing coordination
  - Allow time for proofing in comfortable conditions not under site time pressures
- Can be 24 hour production
  - Sites need special permission for 24 hours

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Layered Construction

simplifies details and avoids interfaces
Don't puncture DPM, GPM and VB or ATL
add services zones to avoid complications

Ease deconstruction

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

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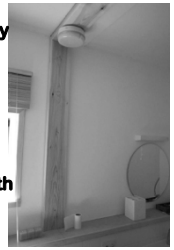
Layered Construction

Avoid chasing masonry
Avoid waste materials
Avoid masonry dust
Avoid conduits
Avoid Rendering-in

Surface mount all services and cover with hollow Skirtings, dado, etc.



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Avoiding Complex materials or assemblies

Complexity v Deconstruction
Separation for reuse v Landfill

Avoid difficult materials

- Composites are difficult to separate and recycle
- Decorative and protective coated metal, adhesive and foam insulation
- But Tradis uses timber framing, cellulose fibre boards and recycled newspaper insulation

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Avoid difficult materials

- Decorative and protective coated metal
- Coated aluminium will be recycled
  - But getting coatings off by chemicals or heat creates emissions or hazardous waste
- Currently uncoated often does not get segregated but it has the potential to

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Packaging Deliveries & Site Storage

Prone to damage onsite

Materials Protection:

Full high build micro porous paint/stain scheme over all surfaces in the factory

No absorbent surfaces

Unlike UK practice of priming hidden faces or leaving bare and absorbent

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BedZED Beddington Sutton Architect: Dr Bill Dunster

Packaging & Protection:

Palleted
Corner protection
Lateral bracing
Poly wrap
Breathing holes
Site tarpaulin
But:
Adjacent to traffic routs: potential splash and damage
Lean doors on it
JIC not JIT

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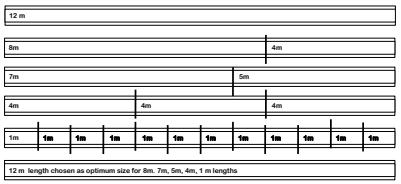
BedZED Beddington Sutton Architect: Bill Dunster

Delivery Volume



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Delivery Sequence

- The first to be constructed
  - to be delivered first
- Large deliveries and containers
- First to be installed
  - last on lorry and last in container
  - First off and first out, used first
  - No materials delivered extracted, spread out and sorted in any weather conditions

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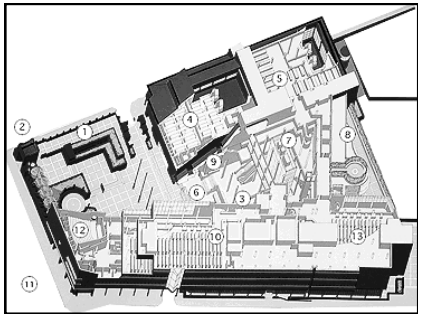
Assembly Sequence

- Chinese jigsaw puzzles
- Assembly sometimes need to follow a sequence
- One partly assembled piece may prevent the assembly of another
- If you test assemble in the factory you may discover it,
- if you do, pass the information to site

305



Design-in material storage for on-going maintenance

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10m tonnes/a over ordered

- Provide space in the building to store unused materials
- For snagging
- For 12 months defects
- For employer to maintain the building
- Make sure contractor gets paid for it
  - if the building is re-measured on completion and only installed is paid for

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Spares from batch for maintenance

- Long life buildings: lots of materials to maintain over life
- BLE: Basement 500 year design life
- 1 store per fire compartment for spares (PVC flooring)
- Bluewater: Fix spare balustrade parts
- Car park structure: bolt in spare railings

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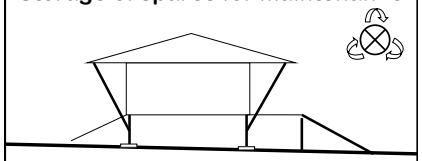
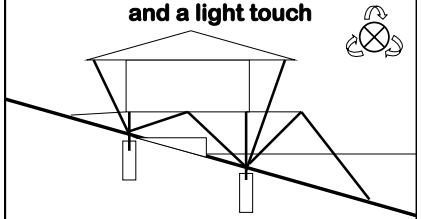
Storage of spares for maintenance



Spaces of services and storage

310

Storage of spares for maintenance and a light touch



Spaces of services and storage above flood zone 311

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

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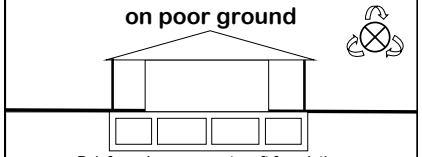
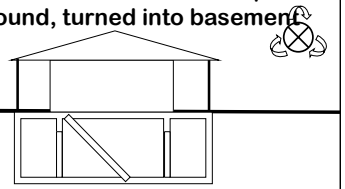
Reinforced eco-concrete Cellular Raft foundation on poor ground



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

313

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

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Space for Waste

Temporary Building made from waste

"Space Of Waste"

- An Inspirational Take On Waste Reduction
- A temporary building designed and built
- University of Sheffield architecture students
- raise awareness of diverting waste material from landfill
- nominated for the AJ Small Projects Award
- This highly unusual temporary building
- Is made entirely from other people's rubbish!
- Commissioned by a free online waste exchange for businesses in Yorkshire & Humber.
- www.whywaste.org.uk

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- Challenged the student design team
- find and use reclaimed and recycled material from the waste exchange
- Walls made of waste 'skeleton' sheets of birch plywood left over from the manufacture of children's furniture;
- Wall made from bailed blocks of polythene bags.
- Roof comprising 900 scrap carpet tiles
- Building's lighting: chandeliers made from cylindrical Perspex off cuts from a shop-display manufacturer.
- Construction aspects of the build were overseen by Geoff Stow, self-build expert and timber-frame construction lecturer at the Centre For Alternative Technology in Wales
- Structural calculations by Arup.

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- Winners of the AJ Small Projects Award will be announced in March
- see photos of the project
- www.beat.org.uk/bm/why_waste/space_of_waste/index.shtml
- Source:
- www.get-sust.com/newsletters/issue34.html

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Waste in use

- Don't forget to make space for segregating and compacting packaging waste
  - to return to sender under packaging producer obligations
  - Or divert from landfill to recyclers
- Especially in Retail
  - Bullring is an example where there is too little room

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Facts and Figures

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- Brian Murphy ONC HNC Construction, BSc Dip Arch (Hons+Dist)
  - Technician and Architect by Training
  - Specification Writer by Choice
  - Environmentalist by Actions
  - Writer and Educator as a Calling
- Greening up my act since 1999
- Founded National Green Specification 2001
- Launched www.greenspec.co.uk 2003
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- LinkedIn: BrianSpecMan
- Facebook: BrianSpecMan http://www.facebook.com/brianspecman
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