Lecture 04 - External Walls, Openings & Windows

Advanced Technology
Module Code: SCTA1140
Semester A: Weeks 10 - 24
Credits: 15

Module Co-ordinator: Kenny Fitzmaurice
Module Leader: Ilona Hay

Lecturer: Brian Murphy

22nd October 2018

4 Quotes for today:

Build Tight > Ventilate Right

Fabric First (Eco bling last)

No Insulation without Ventilation (PAS 2035)

Build Light > Insulate Right > Solar Tight

Semester A Programme

Week 10	01.10.2018	Lecture 01.	Introduction to Materials	Design Task 01
Week 11	08.10.2018	Lecture 02.	Sustainability Principles	-
Week 12	15.10.2018	Lecture 03.	Building Envelope Principles	-
Week 13	22.10.2018	Lecture 04.	External Walls, Openings & Windows	-
Week 14	29.10.2018	-	Submission	-
Week 15	05.11.2018	-	Independent Study Week	-
Week 16	12.11.2018	Lecture 05.	Floors, Ceilings & Roofs	Design Task 02
Week 17	19.11.2018	Lecture 06.	Guest Lecture: Structural Engineer	-
Week 18	26.11.2018	Lecture 07.	Lighting, Heating, Ventilation, Services	-
Week 19	03.12.2018	Lecture 08.	Stairs, Lifts & Ramps	-
Week 20	10.12.2018	-	Formative Review	Present your Semester A Work
Week 21	17.12.2018	-	Winter Break	-
Week 22	24.12.2018	-	Winter Break	-
Week 23	31.12.2018	-	Winter Break	-
Week 24	07.01.2019	-	Submission	Semester A Work

Semester B Programme

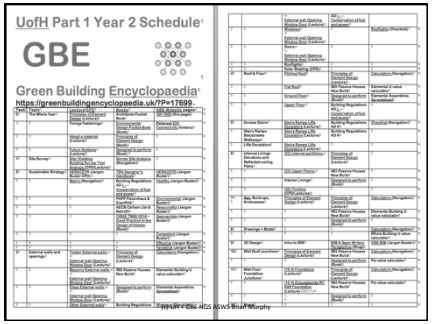
Week 26	21.01.2019	Lecture 09.	Regulatory Framework	Design Task 03
Week 27	28.01.2019	Lecture 10.	Site Analysis	-
Week 28	04.02.2019	Lecture 11.	Building Costs	-
Week 28	05.02.2018		Technology Champion	
Week 29	11.02.2019	Lecture 12.	Future Systems: Sustainability	Design Task 04
Week 30	18.02.2019	Lecture 13.	Guest Lecture: Structural Engineer	-
Week 31	25.02.2019	Lecture 14.	Design to Perform & Detailing	-
Week 32	04.03.2019	-	Class Trip (TBC)	-
Week 33	11.03.2019	-	Independent Study Week	-
Week 34	18.03.2019	Lecture 15	Future Systems: Technologies	-
Week 35	25.03.2019	Lecture 16.	Module Review	-
Week 36	01.04.2019	-	Formative Review	Present your Semester B Work
Week 37	08.04.2019	-	No Lecture	-
Week 38	15.04.2019	-	Spring Break	-
Week 39	22.04.2019	-	Spring Break	-
Week 40	29.04.2019	-	No Lecture	-
Week 41	06.05.2019	-		Semester A & B Work

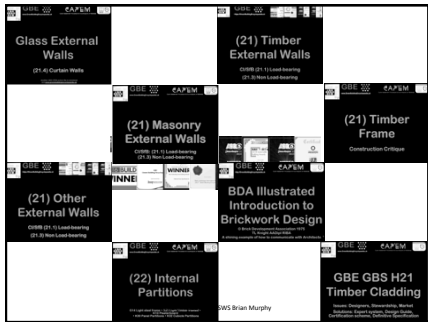
>40 years into 1 Hour won't go

- So I am providing links to other information if you want to know more

- Question Everything
- Don't assume that I know everything
- Don't assume I have cherry picked the best bits
- Don't assume what your being told is the whole story
- Some will hide what they don't want you to know

- Do your best with what you know
- When you know better
- Do better

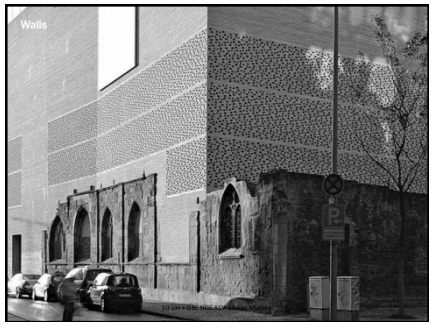




Today's Lecture

- ~~External Wall~~
- Openings
- Windows
- Doors
- Internal Walls/Partitions
- Function + Performance
- Principles of Element Design

- Fabric First: make the building fabric do all the work
- Or you end up with services making up the difference
- We need buildings that do not need loads of services
- consuming loads of energy for the rest of the building's life
- But we do need low level deliberate purposeful ventilation or we die from poor indoor air quality:
- CO2 Carbon Dioxide and VOC Volatile Organic Compounds, Formaldehyde



First Principles

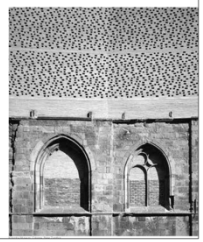
Function of an external wall:

- Environmental control between the external and internal climates of a building

- Support the combined dead, imposed and wind loads of the roof and floor construction, as well as its own combined loads and transfer them safely to a foundation (depending upon the precise nature of the overall structural system)

- Considerations of appearance must be a critical part of the design since to a very large extent an external wall determines the architectural character and quality of a building

This only scratches the surface



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Key Building Regulations

Legal minimum > But 'the Performance Gap' suggests we don't meet this minimum very often

The Building Regulations 2010

Fire safety

APPROVED DOCUMENT **B**

VOLUME 1 – DWELLINGHOUSES

B1 Means of warning and escape
B2 Internal fire spread (linings)
B3 Internal fire spread (structure)

The Building Regulations 2010

Site preparation and resistance to contaminants and moisture

APPROVED DOCUMENT **C**

C1 Site preparation and resistance to contaminants
C2 Resistance to moisture

The Building Regulations 2010
The Building (Approved Inspectors etc) Regulations 2010

Resistance to the passage of sound

APPROVED DOCUMENT **E**

E1 Protection against sound from other parts of the building and dwelling-houses
E2 Protection against sound within a dwelling-house etc

The Building Regulations 2010

Conservation of fuel and power

APPROVED DOCUMENT **L1A**

L1A Conservation of fuel and power

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Wall Actions

- Gravity: downward pull
- Wind: Motive, Destructive, Penetrative
- Rain: Moisture deposition, penetration
- Snow: Moisture deposition, loading
- Moisture vapour: permeation, surface and interstitial condensation, insulation impaired, material degradation
- Sun: Temp variation, thermal movement, solar heat gains, Chemical decomposition
- Dirt and Dust: infiltration, deposition, surface pollution
- Chemicals: corrosion, disintegration, decomposition
- Sound: Noise nuisance, from within and from without
- Attack: Manual, Ballistics, Bomb Blast
- Thermal: heat loss, radiant coolth, condensation, stack effect

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Wall Reactions

- Gravity: Support & restraint
- Wind: rigidity, resilience, sealing, air tightness layers and detailing
- Rain: deflection, impervious skin, absorption and drainage, sealing
- Moisture vapour: resistance, hygro-scopicity, permeability, 'breathing', moisture mass
- Snow: deflection, impervious skin, absorption and drainage, sealing
- Sun: movement joints, insulation, shielding, invulnerable materials, decrement delay
- Dirt and Dust: repulsion, exclusion, shielding, cleaning, covering
- Chemicals: invulnerable materials, exclusion,
- Sound: Insulation, absorption, acoustic mass, separation, isolation,
- Attack: toughness, lamination, edge restraint, edge protection
- Insulating: thermal insulation, k and U value, thermal mass, thermal bridge avoidance/minimisation,
- Glass: G value,

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Principles of Element Design

- Appearance
  - **Interior and exterior materials and finishes**
- Structural strength and stability
  - **Load-bearing**
  - **Wind resistance**
- Weather barrier
  - **Rain, snow, wind, sun,**
  - **dirt dust pollution**
- Durability
  - **Moisture resistance, frost, mould**
  - **Moisture Mass & Hygroscopicity**
  - **Ozone and sunlight degradation**
- Thermal Performance
  - **Heat Resistance: loss and gain**
  - **Condensation Avoidance**
  - Airtightness
  - Avoidance of Cold Bridges
  - **Thermal Mass**
- Movement
  - **Structural , thermal, moisture, Frost**
  - **Chemical**

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Principles of Element Design

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

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Weather Envelope

Absorbent – Repellent – Open Joint Panelled Masonry – Curtain Wall – Rainscreen

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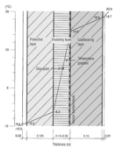
Throwback

The Building Envelope

The problem of heat flow and vapour diffusion

- A building has more than one orientation,
- Subject to different moisture uptake, wind driven rain penetration and solar radiation.
- All of this is variable of over time:
  - Diurnal (night day)
  - Annual (through seasons)
- Static analysis is inadequate
- Dynamic Hygro/Hydro/thermal moisture movement analysis is essential.
- BS 5250 is inadequate
- WUFI or Delphin essential



- This is not UK construction practice or thicknesses.
- Vapour barrier in cavity masonry does not happen in UK
- 150 to 300 mm insulation not precise (for a calculation).
- Beware of incomplete diagrams:
- It shows the 'heat flow' gradient from inside to outside
- It does not show the 'vapour diffusion' line
- It does not show the crossing point so the 'Due Point' is entirely speculative
- There is no 'evidence' here, beware Birkhauser

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Lightweight Construction

No solar tight insulation > overheats > open vents

Build Light > Insulate Right > Solar Tight

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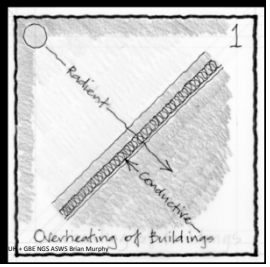
Radiant verses Conductive heat flows

Insulation needs to resist both or overheating occurs



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Solid Construction

- Solid in this context means heavy not opaque
  - Density
  - k value
  - Specific heat capacity
- Opaque can also be beneficial
  - Less solar gains through glazing in summer
- If masonry walls and concrete roof:
  - Can be solar tight
- Long Decrement Delay 10 hours
  - cool retreat in summer
- Albedo effect can be beneficial:
  - White for the planet
  - Earth Albedo = 0.39
- Building Solar exploitation
  - White at equator,
  - Black at poles

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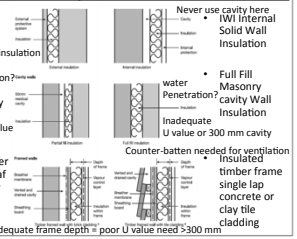
Solid Wall, Cavity Wall, Timber frame

- EWI External Solid Wall Insulation
  - Never use plastic insulation or cement render
  - Cooling ventilation?
- Partial Fill Masonry Cavity Wall insulation
  - Inadequate U value
- Insulated timber frame inner leaf Masonry outer leaf
- IWI Internal Solid Wall Insulation
  - Never use cavity here
- Full Fill Masonry cavity Wall Insulation
  - water Penetration?
  - Inadequate U value or 300 mm cavity
  - Counter-batten needed for ventilation
- Insulated timber frame single lap concrete or clay tile cladding
  - Inadequate frame depth = poor U value need >300 mm



Extract from Building Regulations Approved Document C (Dampness and Health)

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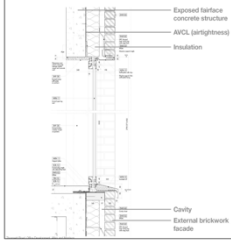
Brick/Blockwork External Wall



Insulation to window relationship good
But gap could be insulated/ sealed

Double glazed windows inadequate for future

Triple glazed windows enable internal surface temperature closer to external wall internal temperature

Minimise perception of down drafts and poor thermal comfort

Cavity closer creates thermal bridge through insulation

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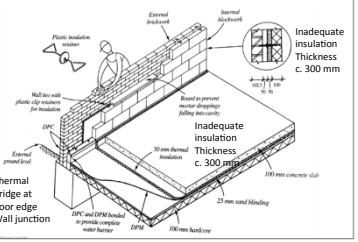
Brick/Blockwork External Wall



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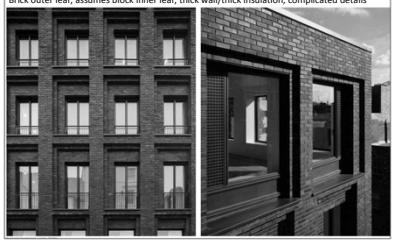
Brick/Blockwork External Wall

Brick outer leaf, assumes block inner leaf, thick wall/thick insulation, complicated details



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Timber External Wall

Platform Timber Frame

- Conventional Thinking:
- Vapour Barrier (VB) and Breather membrane (BM) needed with non-breathing insulation
- Current thinking:
- Airtightness layer (ATL) or Intelligent ATL and Wind tightness (WTL) needed for Breathing insulation
- Platform frame and ATLs are more complicated but understood

- Plastic, glass and stone wool is okay winter insulation (conduction) but not good summer insulation (radiation)
- Current U values need c.300 mm of thermal insulation
- Depending upon insulation materials
- Breathing insulation may need to be thicker
- Studs 140 or 190 mm inadequate for the job

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Timber External Wall

Timber framed external wall

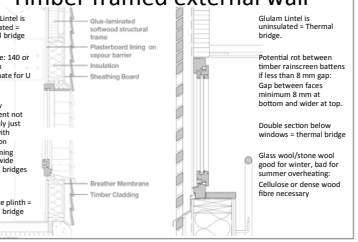
Glulam Lintel is uninsulated = Thermal bridge

Stud size: 140 or 190 mm inadequate for U value

Window placement not ideal only just aligns with insulation

But framing makes wide thermal bridges

Concrete plinth = thermal bridge



Glulam Lintel is uninsulated = Thermal bridge.

Potential rot between timber rainscreen battens if less than 8 mm gap: Gap between faces minimum 8 mm at bottom and wider at top.

Double section below windows = thermal bridge

Glass wool/stone wool good for winter, bad for summer overheating:
Cellulose or dense wood fibre necessary

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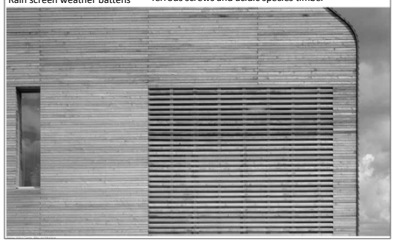
Timber External Wall

Rain screen weather battens

Grey stains due to timbers too close or ferrous screws and acidic species timber



Cladding

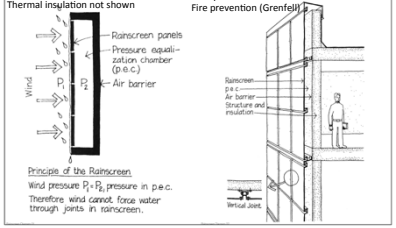
Corten self rusting steel;

Concrete or render finish?

Rainscreen Cladding

Some rain will pass through joints
Air barrier is also a water barrier
Thermal insulation not shown

Thermal insulation not shown only annotated
Thermal Bridges Prevail
Cavity barriers at floor levels
Fire prevention (Grenfell)

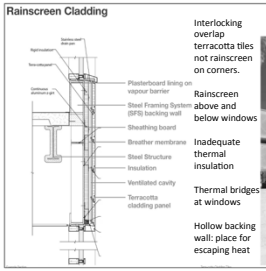


Principle of the Rainscreen

Wind pressure $P_1 = P_2$ pressure in p.e.c.

Therefore wind cannot force water through joints in rainscreen.

Rainscreen Cladding



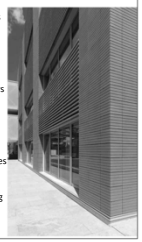
Interlocking overlap terracotta tiles not rainscreen on corners.

Rainscreen above and below windows

Inadequate thermal insulation

Thermal bridges at windows

Hollow backing wall: place for escaping heat



Rainscreen Cladding

Slates do not have gaps but overlaps so are a form of tiling not Pressure Equalised rainscreen

- Wall Openings
- Windows
- Doors
- Ventilation Louvres (not covered by this)
- Solar shading of opening (not covered by this)

First Principles

Functions and key considerations of openings:

- Allows access and egress

- Security

- Allows light in

- Allows views out

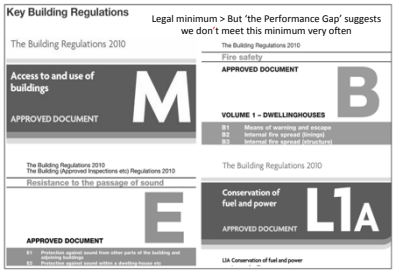
- Doors and windows can be a weak point in the external envelope (weather exclusion, sound control, thermal comfort, fire protection and security)

- Size, shape, proportion, materials and location profoundly influence the overall and detail appearance as well as the aesthetics of a building

This only scratches the surface

Key Building Regulations

Legal minimum > But 'the Performance Gap' suggests we don't meet this minimum very often



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Windows Actions

- Gravity: downward pull
- Wind: Motive, Destructive, Penetrative
- Rain: Moisture deposition, penetration
- Snow: Moisture deposition, loading
- Sun: Temp variation, thermal movement, solar heat gains, Chemical decomposition
- Dirt and Dust: infiltration, deposition, surface pollution
- Chemicals: corrosion, disintegration, decomposition
- Sound: Noise nuisance, from within and from without
- Attack: Manual, Ballistics, Bomb Blast
- Heat:

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Windows Reactions

- Gravity: Support & restraint
- Wind: rigidity, resilience, sealing
- Rain: deflection, impervious skin, absorption and drainage, sealing
- Snow: deflection, impervious skin, absorption and drainage, sealing
- Sun: movement joints, insulation, shielding, invulnerable materials,
- Dirt and Dust: repulsion, exclusion, sheilding, cleaning
- Chemicals: invulnerable materials, exclusion,
- Sound: Insulation
- Attack: toughness, lamination, edge restraint, edge protection
- Heat: insulating glazing, low E glass, Solar control glass

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Windows Outside

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Windows Inside

- trickle ventilation

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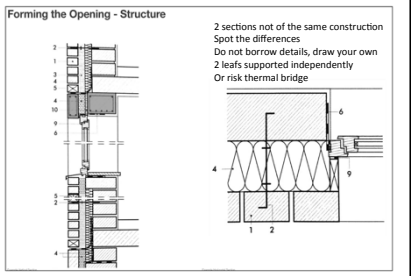

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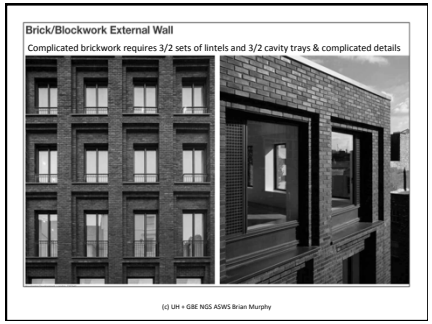

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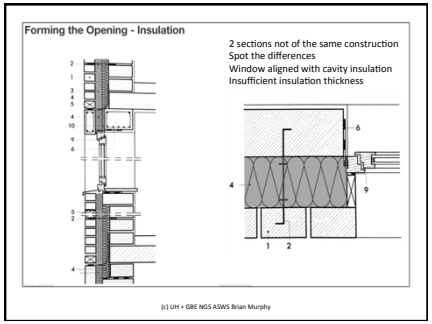

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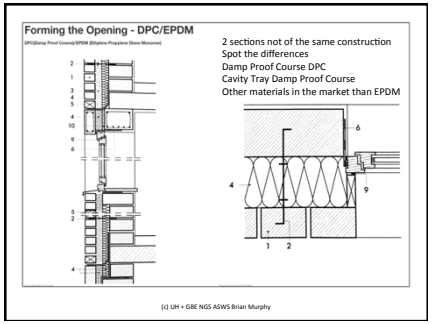

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Openings

Openings: Not/obvious lintel

Look
no
Hands
No
obvious
lintel

Flush
detailing
will
lead
to
shorter
life

External Door Actions

- Gravity: Downward pull, rotation
- Wind: Motive, Destructive, Penetrative, whistling
- Rain: Moisture deposition, penetration
- Snow: Moisture deposition, loading
- Dirt and Dust: infiltration, deposition, surface pollution
- Chemicals: corrosion, disintegration, decomposition
- Sound: Noise nuisance, from within and from without
- Attack: Manual, Ballistics, Bomb Blast
- Heat: Solar Heat Gains, Heat passage

External Door Reactions

- Gravity: Ironmongery Support & restraint
- Wind: rigidity, resilience, sealing
- Rain: deflection, impervious skin, absorption and drainage, sealing
- Snow: deflection, impervious skin, absorption and drainage, sealing
- Sun: movement joints, insulation, shielding, invulnerable materials,
- Dirt and Dust: repulsion, exclusion, sheilding, cleaning
- Chemicals: invulnerable materials, exclusion,
- Sound: Insulation
- Attack: toughness, lamination, edge restraint, edge protection
- Heat: insulating glazing, low E glass, Solar control glass

Door Outside

Door Inside

- Statutory Ventilation areas: trickle ventilation
  - When is a door a windows?
- Thermal insulation, heat losses:
  -
- Solar heat gains: G value of glass
- Emissivity: Low E glass coatings
- Comfort conditions:
  -
- Views out and eye level
- Safety, Containment, Impact,
  -
- Fire: Non-combustible, Low smoke generation

Openings

Left:
Placement creates cutting waste and opening in a joint zone

Right:
Simple uncomplicated

Partitions /Loadbearing Internal walls, Solid Wall Solutions

First Principles

Function of an internal wall:

- *Physical space separation*
- Isolation of certain activities
- Fire protection
- Thermal insulation
- Sound control
- Support internal fittings and fixtures
- Pleasing appearance colour and texture
- Structural (depending on structural strategy)

This only scratches the surface

GBE www.GreenBuildingEncyclopaedia.uk CAP'EM Cycle Assessment Procedure for Ecoimpacts of Materials

(22) Internal Partitions

G14 Light steel frame • G20 Light Timber framed • K10 Plasterboard • K30 Panel Partitions • K32 Cubicle Partitions

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Partition Actions

- –
- –
- –
- –
- –
- hygroscopicity, material degradation
- –
- Temp variation, thermal movement, heat gains, Chemical decomposition

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Partition Reactions

- –
- –
- hygroscopicity, permability, breathing, moisture mass
- –
- movement joints, insulation, shielding, invulnerable materials
- sheilding, cleaning
- Chemicals: invulnerable materials, exclusion,
- Sound:
  - Insulation, absorption, acoustic mass, separation, isolation,
- Attack:
  - toughness, lamination, edge restraint, edge protection
- Insulating: thermal insulation, thermal mass,
- Electromagnetic radiation: Absorbs, shields

Partition properties

- –
- –
- –
- –
- joint reinforcement
- –
- Fire resistance, spread of flame
- Stability, integrity, insulation
- –
- Insulation, thermal mass, cold bridge avoidance, air tightness
- –
- Noise barrier, sound absorption, flanking sound,

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Partition Properties

- Movement
  - –
- Security
  - –
- Party walls
  - –
  - Condensation and Insulation, sound control
- Compartment Walls
- Fixed Partitions
- Relocate able Partitions
- Cubicles
- Mobile Partitions

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Key Building Regulations

Legal minimum > But 'the Performance Gap' suggests we don't meet this minimum very often

The Building Regulations 2010
Fire safety
APPROVED DOCUMENT B
VOLUME 1 – DWELLINGHOUSES
B1 Means of warning and escape
B2 Internal fire spread (linings)
B3 Internal fire spread (structure)

Part L
Internal partitions not normally regulated
Insulate to restrict overheating to sunny side

The Building Regulations 2010
The Building (Approved Inspections etc) Regulations 2010
Resistance to the passage of sound
APPROVED DOCUMENT E
E1 Protection against sound from other parts of the building and adjoining buildings

The Building Regulations 2010
Conservation of fuel and power
APPROVED DOCUMENT L1A
L1A Conservation of fuel and power

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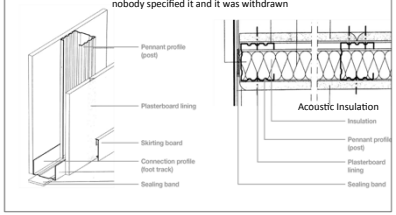
Typical ('demountable') Internal Partition Components

Demolish able: British Gypsum made Demountable, nobody specified it and it was withdrawn



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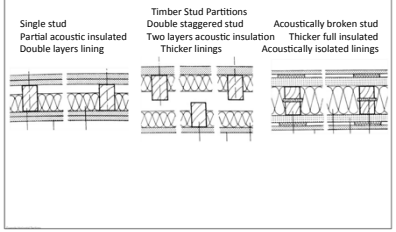
Example Horizontal Wall Sections /Partitions



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Partitions
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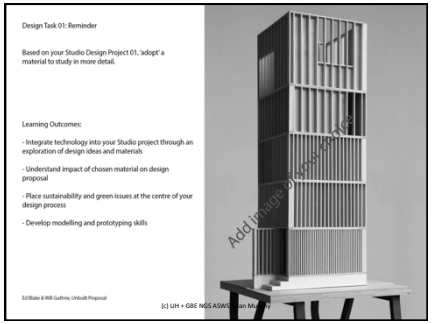
Design Task 01: Reminder
Based on your Studio Design Project 01, 'adopt' a material to study in more detail.
Learning Outcomes:
- Integrate technology into your Studio project through an exploration of design ideas and materials
- Understand impact of chosen material on design proposal
- Place sustainability and green issues at the centre of your design process
- Develop modelling and prototyping skills
Ed Blake & Will Guthrie, Unbuilt Proposal
Add image of your choice
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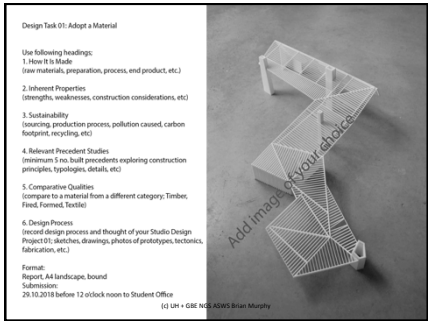
Design Task 01: Adopt a Material
Use following headings:
1. How It Is Made
(raw materials, preparation, process, end product, etc.)
2. Inherent Properties
(strengths, weaknesses, construction considerations, etc)
3. Sustainability
(sourcing, production process, pollution caused, carbon footprint, recycling, etc)
4. Relevant Precedent Studies
(minimum 5 no. built precedents exploring construction principles, typologies, details, etc)
5. Comparative Qualities
(compare to a material from a different category; Timber, Fired, Formed, Textile)
6. Design Process
(record design process and thought of your Studio Design Project 01; sketches, drawings, photos of prototypes, tectonics, fabrication, etc.)
Format:
Report, A4 landscape, bound
Submission:
29.10.2018 before 12 o'clock noon to Student Office
Add image of your choice
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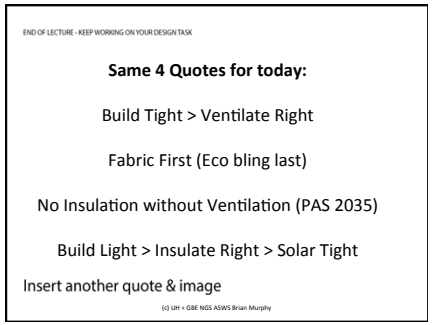
END OF LECTURE - KEEP WORKING ON YOUR DESIGN TASK
Same 4 Quotes for today:
Build Tight > Ventilate Right
Fabric First (Eco bling last)
No Insulation without Ventilation (PAS 2035)
Build Light > Insulate Right > Solar Tight
Insert another quote & image
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