

Lecture: Adopt a material

Advanced Technology

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Material Groups

- C01 C02 Ceramics
- F01 F02 Found Objects
- H01 H02 Hand Tools
- P01 P02 Plaster
- T01 T02 Timber
- TX01 TX02 Textiles

Your task: collate & record

- **How it is made**
 - Raw materials, preparation, process, end product
- **Inherent Properties**
 - Strength, weakness, construction considerations
- **Sustainability**
 - Sourcing, production process, pollution caused, carbon footprint, recycling
- **Relevant Precedent Studies**
 - Construction principles, typologies, details
- **Comparative Qualities**
 - Compare with the other material groups
- **Design process**
 - Sketches, drawings, prototypes, tectonics, fabrication³

C01 C02 Ceramics

- **Starts as Clay from the ground**
 - Excavated subsoil (inert) below topsoil (alive)
 - Blended: clays, straw reinforcement, fine sand aggregate, sawdust, mineral dyes
 - Format: bricks, block, rammed earth, cob
 - Wooden moulds, clay thrown into brick mould,
 - Extruded and wire cut into bricks
 - Can have texture added by roller
 - Common bricks can have sand added to face
 - Small balls into formwork and rammed in 75 mm layers squeezed to 50 mm visible layers
 - Loadbearing
 - But susceptible to thermal/moisture movement

C01 C02 Ceramics

- Can be sun/air dried: moisture driven off
 - Solar energy intensive but free and no carbon
 - Sets dry but no curing nor strengthening
 - Can be softened with water or steam
 - Can reabsorb moisture vapour moderating humidity, avoiding need for ventilation or air conditioning

C01 C02 Ceramics

- **Can be fired (cooked)**
 - High temperature, Energy intensive,
 - Carbon level depends on fuel choice
 - Clays can have an inherent fuel gas released by heat during firing but flue emissions increase
 - Can be glazed (colour coated) for first firing
- **Can be double fired**
 - Terracotta: glazed for second firing
 - Glazes: Matt to Gloss and big colour range
 - Including mimicking stone

C01 C02 Ceramics

- **Formats:**
 - Bricks, Glazed Bricks, Blocks,
 - Floor/wall Tiles, Glazed tiles, Roof tiles
 - Rain screen extrusions
 - Ornate Sculpture (mimicking stone carving)
- **Early form of mass production**
 - Stone masons or clay modelers carved ornate pieces,
 - Moulds made or taken, many copies made in terracotta
- **Terracotta hollow blocks**
 - filled with lightweight aggregate with cement matrix
- **Lightweight extruded hollow blocks**
 - insulating voids and long pathways make good U values
- **Crushed brick:**
 - consolidated hardcore, piling mat, brown roof gravel

C01 C02 Ceramics

- **Loadbearing capacity**
 - Increases with firing temperature
 - And choice of clay
 - Formation of structure: walls, timber arch,
- **Moisture permeable: especially with lime mortar jointing**
- **Water resistant: with cement mortar used as 3 course bricks DPC**
 - Engineering brick Damp Proof Course with strong cement mortar
- **Acoustic properties due to mass**
- **Fire Resistant due to firing**
- **Thermal mass due to density: Good**
- **Thermal insulation: winter heat loss (conductivity k value): Poor**
- **Decrement Delay: summer solar radiation protection**
 - Thick walls: long delay
 - Thin roof tiles: little protection
- **Floor and wall tiles:**
 - Strong, tough, easy-clean,
 - Water or chemical-resistant (Grouting performance to match)
 - Slip resistance: Glazed tile slip, unglazed grip
 - depends on footwear: Rubber boots grip, bare feet may slip

C01 C02 Ceramic

- Rammed Earth Wall
 - <https://www.pinterest.co.uk/bmurphy1390/rammed-earth-wall/>
- Cob
 - <https://www.pinterest.co.uk/bmurphy1390/cob/>
- Brickwork
 - <https://www.pinterest.co.uk/bmurphy1390/f10-brickwork/>
- Mortar
 - <https://www.pinterest.co.uk/bmurphy1390/z21-mortar/>
- Roof wall tiles
 - <https://www.pinterest.co.uk/bmurphy1390/h6-slating-tiling-roofing-cladding/>
- Timbrel Arch
 - <https://www.pinterest.co.uk/bmurphy1390/timbrel-arch-construction/>

F01 F02 Found Objects

- Which materials: [_____]
- How it is made
 - Raw materials, preparation, process, end product
- Inherent Properties
 - Strength, weakness, construction considerations
- Sustainability
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F01 F02 Found Objects

- **Scope:**
 - Circular economy (dismantled building parts)
 - Architectural Salvage (Hand crafted)
 - Construction reclaim (others components)
 - ‘Dumpster diving’ (with owners permission)
 - (surplus to requirements, off-cuts, damaged)
 - Materials Exchanges (surplus to requirements)
 - Local Resource Locator websites
 - Surplus to requirements, Returned to stock
 - Industrial process waste: eg. laser cut waste

F01 F02 Found Objects

- **Environmental impacts:**
 - Historic manufacture (so impacts ignored?)
 - LCA Life Cycle Analysis (impacts apportioned to main product and bi-product or co-product)
- **Reclaimed Product Quality:**
 - Product Passport from first life/use
 - Based on Product Specification
 - See BAMB EU Horizon 2020 funded Project
 - Buildings as Material Banks www.bamb2020.eu
 - <https://passports.bamb2020.eu>
 - User name: guest password: bambplatform

F01 F02 Found Objects

- **Size is everything**
 - Ideally modular and consistently so
 - Designed to reduce waste in first use
 - Design with the same in mind or waste more in second use
- **Fixing methods is fundamental**
 - Design for ease of assembly, dismantling and reassembly
 - State of repair in fixing zone
 - Take care of buried 'lost' fasteners
 - They will wreck your tools: saws and drills
 - Companies with big magnets extract fasteners

F01 F02 Found Objects

- Lazar cutting scraps v efficiency iterations
- <https://www.pinterest.co.uk/bmurphy1390/resource-effective-design/>

H01 H02 Hand Tools

- Which tools: [_____] Which materials: [_____]
- How it is made
 - Raw materials, preparation, process, end product
- Inherent Properties
 - Strength, weakness, construction considerations
- Sustainability
 - Sourcing, production process, pollution caused, carbon footprint, recycling
- Relevant Precedent Studies
 - Construction principles, typologies, details
- Comparative Qualities
 - Compare with the other material groups
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 - Sketches, drawings, prototypes, tectonics, fabrication

Hand Tools/ Hand crafted materials

- Clay: See C01 C02 Ceramics above
- Plaster: See P01 P02 Plaster below
- Timber: See T01 T02 Timber below
- Textiles: See TX01 TX02 Textiles at end
- Metals: See next
- Machining Materials: See after Metals

Metals

- Metals
 - <https://www.pinterest.co.uk/bmurphy1390/z11-metals/>

Machining Sheet Materials

- **Lazar cutting**
 - <https://www.pinterest.co.uk/bmurphy1390/lasar-cutting/>
- **CNC Milling**
 - <https://www.pinterest.co.uk/bmurphy1390/cnc-millingcutting/>
- **Resource Efficiency**
 - Lazar cutting scraps v efficiency iterations
 - <https://www.pinterest.co.uk/bmurphy1390/resource-effective-design/>

P01 P02 Plaster

- **Materials:**
 - Clay,
 - Horse manure, grass stem reinforced
 - Lime: Derived from Limestone (UK) or marine shell (Holland)
 - Cement: OPC, GGBS or blended
 - Gypsum, Desulferisation gypsum (power station flue gas filtering)
 - Diatomaceous Earth (prehistoric ocean floor sediment)
- **Ingredients:**
 - Bulking/Strengthening/texture/colour: Sand and fine aggregate
 - Reinforcement: horse hair, hemp shiv,
 - insulating aggregates: Cork granules, hemp shiv,
 - Pigments: minerals
- **Mixes:**
 - Cement/lime/sand,
 - Lime/clay/diatomaceous earth/cork granules
 - Hemp/lime, Hemp/lime/cement/aluminium oxide

P01 P02 Plaster

- **Backing/Substrate:**
 - Solid walls:
 - Masonry with raked joints for key
 - Cast concrete with hessian in formwork
 - Smooth concrete may need primer
 - Wattle and daub
 - oak strips weaved and lime plaster
 - Metal meshes for gypsum plaster
- **Application:**
 - By hand: leaving hand and finger prints
 - Mortar board > trowel > backing then trowelled smooth
 - Projection: render flicked onto backing: good bond, peaky texture
 - Pebble dash: texture and colour pebbles added to peaky surfaces
 - Pumped through hose: smoothed by trowel
 - Parge coats: airtight before plasterboard
 - Plaster: airtight without plasterboard
 - Wet trade requires time to dry before following trade (paint)

P01 P02 Plaster (internal)

- Properties:
 - Clay: see C01 C02 Ceramics: (Unfired only)
 - Internal only (unless protected from weather)
 - Moisture mass: moderates humidity
 - Absorbs smells, good for bathrooms
 - Absorbs electromagnetic radiation (wifi etc)
 - High density: adds thermal mass
 - Low skill and strength needed, DIY repairable
 - Add mineral dye; clay skim coats
 - Inert waste, add back to soil?

P01 P02 Plaster (internal) Render (external)

- Properties:
 - Lime:
 - Alkali: Dangerous in the wrong hands (Not DIY)
 - Active waste: in landfill until hydrated, set and strengthened
 - Anti bacteria
 - Moisture mass: moderates humidity
 - Moisture permeable, moisture transport
 - Some carbon sequestration from atmosphere
 - Weaker than cement, flexible,
 - Reclaimable and recyclable (adding heat)
 - Medium density: medium thermal mass

P01 P02 Plaster (internal) Render (external)

- Properties:
 - Cement:
 - High embodied energy and carbon
 - (8-10% of manmade carbon dioxide)
 - Stronger than lime, less flexible, less forgiving
 - Water and water vapour resistant
 - Traps water in walls with no way out
 - Saturates embedded timbers leading to rot and structural failure
 - Never use cement anywhere on or in historic buildings (pre 1919)
 - Inert waste in landfill once set

P01 P02 Plaster (internal)

- Properties:
 - Gypsum: (internal)
 - Lower embodied energy and carbon
 - Water and water vapour resistant
 - Traps water in walls with no way out
 - Saturates embedded timbers leading to rot and structural failure
 - Avoid gypsum plaster inside external walls in historic buildings (pre 1919) (use lime or clay)
 - Stable Non-Reactive Hazardous waste in landfill (equivalent to asbestos for different reasons)
 - Potential to react with landscape waste
 - Release sulfur to atmosphere making acid rain
 - More expensive to dump so use it wisely

P01 P02 Plaster

- Performance & Application:
 - Hemp-lime:
 - Insulating Render/Insulating Plaster
 - Applied very thickly 300 mm not unusual
 - Slow to set, hydrate, strengthen
 - Ultimate Strength: Less than 3 kN/m²
 - Once fully hydrated (>1 year) performs far better than predicted.
 - Off site air drying can speed up process
 - Exhibits a phase change characteristic
 - Some add:
 - Cement for fast initial set and drive the lime to hydrate faster
 - Aluminium oxide to react with cement and foam up for insulation function

P01 P02 Plaster

- **Performance and Application:**
 - Diatomacious earth/clay/lime/cork granules:
 - Insulating:
 - External Render, Internal Plaster, Floor Screed
 - Airtight application, smooth or textured finish
 - High thermal mass
 - High decrement delay
 - Summer solar protection
 - Moisture Permeability (moisture escapes)
 - Hygroscopicity (Moisture buffering)
 - Thicknesses: 40-100 normal
 - much thicker possible
 - Value engineering: One-coat one-trade multi-functional multi-performance finish

P01 P02 Plaster

- Render
 - <https://www.pinterest.co.uk/bmurphy1390/m21-external-insulation-with-rendered-finish/>
- Cob
 - <https://www.pinterest.co.uk/bmurphy1390/cob/>

T01 T02 Timber

- **Raw materials: (A seasonal crop)**
 - **Hardwood: Deciduous, Broadleaf**
 - **Softwood: Coniferous, Pine needs and cones**
 - **Moonwood: winter: low sap, night time, least moon gravity, (sacred in some societies?)**
- **Manufactured:**
 - **Glulam Glued laminated wood: frames**
 - (strength where its needed, weaker where it is not)
 - **LVL Laminated Veneer Lumber**
 - (using thinnings, thin layers same direction)
 - **CLTP Cross Laminated Timber Panels**
 - (using thinnings, softwood/plywood in layers)
 - **Other compound sections**

T01 T02 Timber

- Timber Panel Products:
 - Plywood: thin leafs of wood, glued layers, layers at right angles
 - Particleboard:
 - Chipboard (chips),
 - OSB (shavings),
 - Wood fibre boards,
 - MDF Medium density fibreboard,
 - medium board,
 - hardboard
 - Wood fibre Insulation boards and batts
 - Breathing, sheathing, thermal + acoustic insulating

T01 T02 Timber

- Ingredients:
 - Treatment: (killing chemistry)
 - Preservatives, Fire protection,
 - rot resistant, insect resistant
 - Salts: added to recipe
 - offering any of above treatments
 - Borax mineral (as benign as possible)
 - Heat Treatment: Remove nutritional content for Durability

T01 T02 Timber

- Assembly:
 - Geometry, mechanical connection, friction, gravity
 - Adhesives:
 - Historic: animal glue;
 - Modern: synthetic high performance
 - Fasteners:
 - Historic: Hardwood Dowels,
 - Modern: Metals, plastic, chipboard biscuit,

T01 T02 Timber

- **Grown:**
 - Photosynthesis: nature converting sunlight and Carbon dioxide into cellulose and oxygen (great synergy with humans)
 - Carbon Dioxide Sequestration = Carbon negative
 - Low energy input with carbon based petrol chain saws
 - Transport emissions or floated down rivers, if not remote
- **Source:**
 - Forests: but ideally very selectively leaving forest intact
 - Plantations: thinnings or the final crop
 - Replanting more trees not palm oil: Sustainable management
- **Certified Sustainable:**
 - looking after nature and indigenous people
 - FCS Forest Stewardship Council 'or equivalent'
 - Chain of Custody: Plantation > Joiner or Plantation > Building site
- **Certified legal: Just got easy**
 - EUTR EU Timber Regulations EU Funded Project
 - www.nepcon.org/sourcinghub

T01 T02 Timber

- **Processing:**
 - Debarked (cork comes from bark)
 - Sapwood removed (Perishable recently living, with sap flowing in the veins)
 - Heartwood saved (durability resides here)
 - Sawing, cutting arrangement (waste in sawdust and scraps)
 - Planing, leaving rough or adding texture
 - Waste scraps: fuel or into timber panel products
 - Machining Energy's carbon: reduces the carbon negativity of timber (but not a lot)

T01 T02 Timber

- **Properties**

- **Durability:**

- depends upon species
 - will change if grown in different climates
 - is classified and applicable to end use

- **Grain:**

- give strength in one direction and weakness in others
 - figuring is not always the same as grain

- **Machine able to varying degrees:**

- grain direction dictates, craftsmen know-how

- **Designers/Engineers exploit grain direction**

- **Manufacturer invent products to solve weaknesses**

T01 T02 Timber

- Connecting Hand made joints
- Paul Sellers does a fine job of a Mortice and Tenon joint in 30 minutes, very detailed commentary
 - <https://uk.video.search.yahoo.com/yhs/search?fr=yhs-imt-brwsrex&hsimp=yhs-brwsrex&hspart=imt&p=mortice+and+tenon+joint+video#id=1&vid=6373eb34d00240e8cc58fdd3b7a112dc&action=click>
- Drawbored M&T joint with very different approach in 10 minutes, with the magic touch at the end
 - <https://uk.video.search.yahoo.com/yhs/search?fr=yhs-imt-brwsrex&hsimp=yhs-brwsrex&hspart=imt&p=mortice+and+tenon+joint+video#id=6&vid=76f979695f3693e3545e83b045019817&action=view>
- And some serious 3D dovetails and a whole lot more in 16 minutes
 - <https://www.youtube.com/watch?v=0kgCsZJGluc>

T01 T02 Timber

- Connecting: Fixings Fastenings
 - <https://www.pinterest.co.uk/bmurphy1390/z20-connectivity/>
- Timber Structure
 - <https://www.pinterest.co.uk/bmurphy1390/g20-timber/>
- Timber
 - <https://www.pinterest.co.uk/bmurphy1390/z10-purpose-made-joinery/>
- Shingles and Shakes
 - <https://www.pinterest.co.uk/bmurphy1390/h64-shingles-shakes/>
- Plywood furniture
 - <https://www.pinterest.co.uk/bmurphy1390/n20-plywood-furniture/>

TX01 TX02 Textiles

- Scope:
 - Carpet/rugs, underlays,
 - Hung fabrics
 - Stretched fabrics,
 - Furniture upholstery,
 - Geotextiles,
 - Recycled fabric insulation (denim, cotton)
- Materials:
 - animal wool/hair: sheep's wool,
 - insect: cotton, spiders web, silk,
 - Animal or fish leather,
 - Synthetic plastics, Bio-plastics
 - Blends of natural and technical/synthetic
 - (contrary to Cradle to Cradle C2C principles)

TX01 TX02 Textiles

- **Ingredients:** Sheep dip (historic but might persist), animal droppings, tangles, thorns, seeds/husks, insect eggs,
- **Process:** separating, washing, carding, combing, dying, weaving, trimming, edging, sewing
- **Impacts:** unhealthy dip, waste, chemically intensive dying, water polluting, waterway/waterbody polluting.
- **Additional treatments:** moth deterrent, fire treatment in upholstery

TX01 TX02 Textiles

- Weaving gives strength, texture, pattern, rhythm, colours
- Different weaves make fabric hang/flow/stretch/shrink/hug differently
- Treatments improve: fire properties, durability
- Some moth killer treatments:
 - CNS Central Nervous System depressants
 - Invented by Germans to kill British in WW World Wars
 - Now we douse our carpets and fabrics

TX01 TX 02 Textiles

- Applications & Performance:
- Carpet: Thermal insulation: Thermal Comfort, Acoustic: Absorption, Tactile
- Curtains: Solar control, Privacy, Black out, Draft lobby at doors, Thermal insulation at windows, Fire resistance (Stage curtain)
- Wall and Ceiling linings: Decoration, Colour, Acoustic Absorption, may need to be low surface spread of flame and non-combustible
- Furniture: Linings, Upholstery (fire/smoke properties)

Feedback

- These files are created by generalists with a big dollop of green flavour
- These files are updated from time to time
- We are not experts so from time to time these file may get out of date or may be wrong.
- If you feel that we have got it wrong please let us know so we can put it right

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- Brian Murphy BSc Dip Arch (Hons+Dist)
 - Architect by Training
 - Specification Writer by Choice
 - Environmentalist by Actions
- Greening up my act since 1999
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