Full Circle to Reuse

A guide by Elliott Wood and
Grosvenor Britain & Ireland

A guide to deconstructing buildings for circular Reuse

Tick-Tock.
Tick-Tock.
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Tick-Tock.
Tick-Tock.

Time is
running ou

Of the 33.1 billion tonnes of man-made CO_2 created worldwide, 40% is attributable to the construction industry.

The demolition, and excavation debris from the construction industry represents 63% of total annual UK waste.

An estimated 80% of a product's environmental impact is determined at the design stage.

The only way forward

"We believe that the Reuse of second-hand construction materials is the only way forward. The industry has to establish a viable second-hand market which deals with storage, cataloguing and recertification. This is only in its infancy but with the right investment and government support will, we believe, become the norm."

Gary Elliott, Elliott Wood

As engineers we understand the construction industry contributes to a significant carbon footprint, much of which is attributed to the embodied carbon of building materials.

In addition, the construction, demolition and excavation debris represents 63% of total annual UK waste.

Whilst there is a high landfill diversion rate, most of the building components are recycled or downcycled, which in turn, reduces their value.

If we can Reuse existing buildings and the materials held within them we'll keep these circulating at their highest value and prevent the need to source new manufactured materials.

This guide aims to unlock the unrealised value of building materials within existing and occupied buildings to create these Reuse opportunities.

The purpose is to contribute to make Reuse the norm for the construction industry to address the global climate crisis.

It focuses on determining structural materials behind finishes, the main challenge when establishing the structure of existing and occupied buildings.

A methodology to assess the Reuse potential of building materials is presented consisting of these four streams of work:

1
Data collection to establish the building layout.

2
Non-destructive investigations to determine the structure behind the finishes.

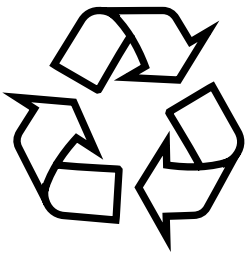
3
Inventory and structural sketches of the individual elements of the structure.

4
Evaluation of Reuse potential of steel, timber, masonry, and concrete elements.

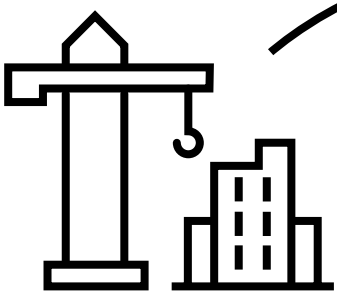
All of which is mapped against the RIBA Plan of Work 2020 indicating the proposed stage at which the new steps are to be undertaken.

To turn full circle

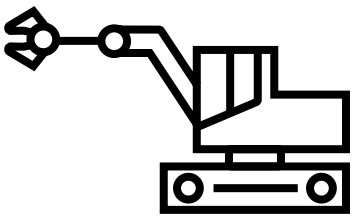
Downcycling/ Recycling



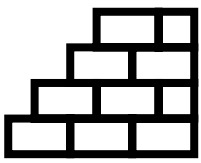
Deconstruction

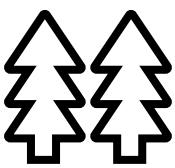


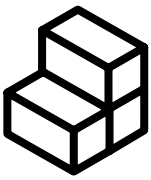
Demolition



Manufacturing of construction materials

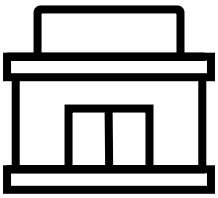






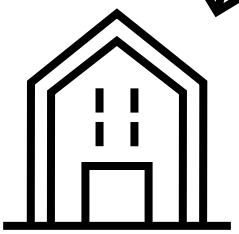
"We cannot build our way out of the climate emergency. Building anything costs embodied carbon – emissions the planet cannot afford. We must work with what we've already got by repurposing existing buildings and reusing the materials contained within them. And it needs to happen now."

Penny Gowler, Elliott Wood

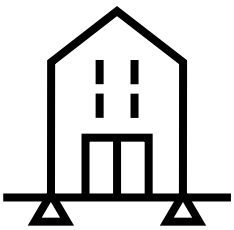


Salvage companies

Buying materials for Reuse



Design for disassembly



Second, third service life

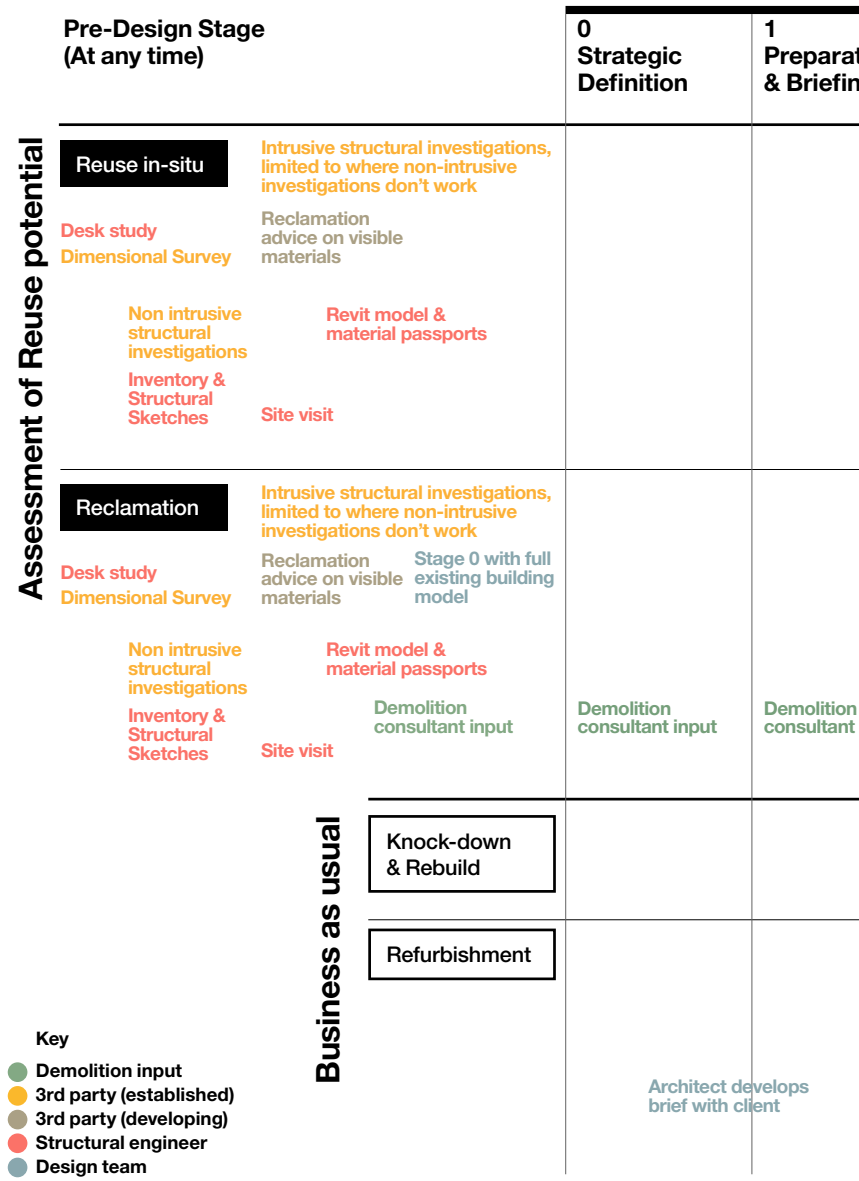
Construction

12 Steps to Reuse

01 Mapping by RIBA Stages
02 Assessing Potential
03 Surveys
04 Structural Investigations
05 Inventory + Structural Sketches
06 Practical Deconstruction

01

Mapping by RIBA Stages



This chart outlines the process for the Reuse assessment of materials in existing buildings.

Crucially, it's mapped against the different stages of the RIBA plan of work 2020, to show where they can be incorporated into a project.

Key to delivery is ensuring the gathering of information, through investigations and surveys, is undertaken at the very earliest opportunity – even before a project has been officially started.

In parallel with this, A demolition consultant should be involved from the start and appointed as a part-time consultant within the design team.

tion ng	2 Concept Design	3 Spatial Co-ordination	4 Technical Design	5 Manufacturing & Construction
	Targeted structural investigations Conceptual design using available materials	Targeted structural investigations Source second-hand materials	Targeted structural investigations Procure second-hand materials	Revit model & material passports
input	Conceptual design using available materials Material testing & grading certification Demolition consultant input	Source second-hand materials Markets for reclaimed materials Demolition consultant input	Procure second-hand materials Demolition consultant input	Revit model & material passports (if only part of the building is deconstructed). Demolition contractor Material testing & grading certification
				Demolition Contractor
	Desk study Dimensional Survey Architect options drive structural investigations	Targeted structural investigations Structural scheme (assumptions)		Demolition Contractor

02

Assessing Potential

Setting intention early

It's crucial that clients set the intention to Reuse early in the process.

Desk study, site visit, photographs & surveys

These are key first steps to be undertaken by experienced engineers, in order to understand a building's structure and potential materials.

Reuse of visible materials

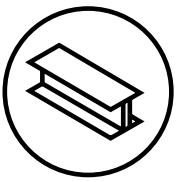
Based on the survey, visible materials can then be assessed by reclamation specialists.

Reuse of hidden materials

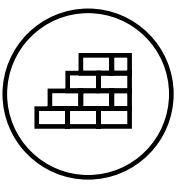
This requires a different approach.

Criteria for assessing Reuse potential

Condition, sufficient quantities, homogeneity, authenticity, economic value, ease of dismantling, manageable logistics, possible destinations for reclaimed elements.

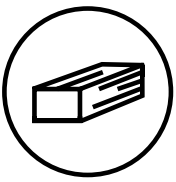


Structural steel beams & columns

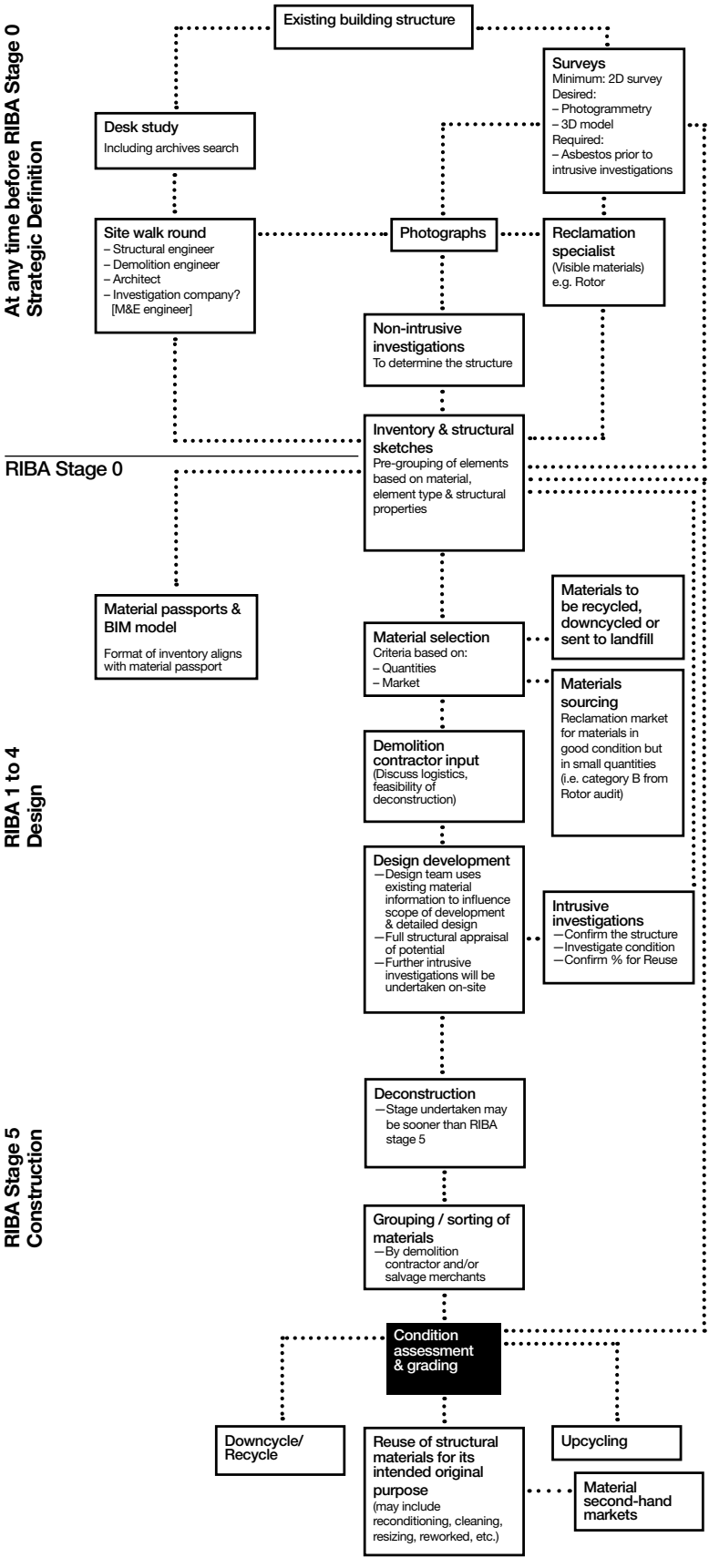


Bricks

Roofing slates



Structural timber


At any time before RIBA Stage 0
Strategic Definition
RIBA Stage 0
RIBA 1 to 4
Design
RIBA Stage 5
Construction
Existing building structure
Surveys
Minimum: 2D survey
Desired:
– Photogrammetry
– 3D model
Required:
– Asbestos prior to intrusive investigations
Desk study
Including archives search
Site walk round
– Structural engineer
– Demolition engineer
– Architect
– Investigation company? [M&E engineer]
Photographs
Reclamation specialist
(Visible materials)
e.g. Rotor
Non-intrusive investigations
To determine the structure
Inventory & structural sketches
Pre-grouping of elements based on material, element type & structural properties
Material passports & BIM model
Format of inventory aligns with material passport
Material selection
Criteria based on:
– Quantities
– Market
Materials to be recycled, downcycled or sent to landfill
Materials sourcing
Reclamation market for materials in good condition but in small quantities (i.e. category B from Rotor audit)
Demolition contractor input
(Discuss logistics, feasibility of deconstruction)
Design development
—Design team uses existing material information to influence scope of development & detailed design
—Full structural appraisal of potential
—Further intrusive investigations will be undertaken on-site
Intrusive investigations
—Confirm the structure
—Investigate condition
—Confirm % for Reuse
Deconstruction
—Stage undertaken may be sooner than RIBA stage 5
Grouping / sorting of materials
—By demolition contractor and/or salvage merchants
Condition assessment & grading
Downcycle/ Recycle
Reuse of structural materials for its intended original purpose
(may include reconditioning, cleaning, resizing, reworked, etc.)
Upcycling
Material second-hand markets

03

Surveys

To get the most value from a survey we need clear information about our buildings.

Ideally, in the future every existing building would have all the materials within them recorded in a full BIM model and associated material passports.

It will of course, take time to get there, but in the meantime information can be sourced in other ways such as 3D laser scanning or even basic design sketches.

3D laser scanning

Enabling the production of 2D CAD plans often with point cloud survey data in RCP form.

2D CAD plans

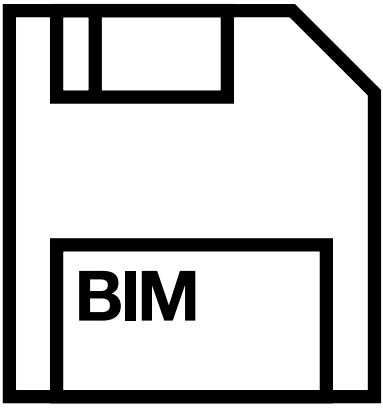
Providing the accurate estimation of spans, lengths and areas for the material quantities in the inventory, whilst also used as guides for modelling the 3D model in Revit.

3D model

Constructed to suit the requirements of the design team (structural engineer, architect and M&E engineer).

Basic sketches

In the worst case scenario, without building drawings, those undertaking site visits will need to make rough sketches of the layout



Type of survey	3rd Party / Design team	Output	£/m2 GIA	Inventory and structural sketches	Reclamation audit (visible)	Reuse potential assessment	BIM model
Basic sketches and general measurements	Design team (structural engineer/ architect)	Sketches and 2D plans	£5	Minimum required	Desired	Minimum required	Useful (to feed into model)
Photographs and videos	Design team (structural engineer/ architect)	Photos and videos	£1 – £2	Minimum required	Minimum required	Desired	Useful
3D Laser	3rd party	2D drawings, cloud point survey and RCP 3D views	£9 – £10	Desired	Desired	Useful	Minimum required (2D drawings)
Matterport	Client / 3rd party	3D views	£2	Desired	Desired	Useful	Useful
*3D model of existing building	3rd party	Base existing Revit model (shell or full)	“shell“ £5 “full“ £15				Desired

04

Structural Investigations

Different non-destructive techniques (NDT) can be used to investigate the structure hidden behind the finishes or the type of structural elements (e.g. concrete-encased steel beams, reinforcement in slabs, wall thickness, web thickness, spans directions, etc.).

Overall, there is a significant amount of data that can be measured quickly without the need to strip out, drill or remove material.

Ideal for occupied buildings

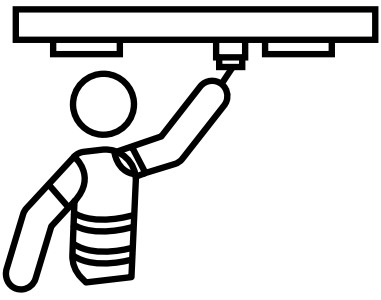
NDT's are key to investigating the structure in occupied existing buildings, minimising disruption to tenants.

Time efficient

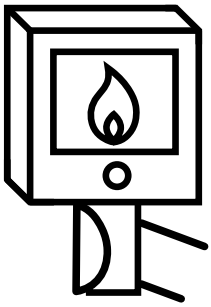
A single day of investigations within an average-sized building is often enough to determine wall, floor, roof and frame construction and determine typical floor spans.

Limitations

There are limitations to these techniques; direct access to the surface material for scanning is required and voided / porous materials can require more traditional opening-up.

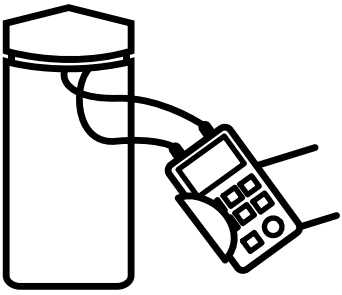


Scanning using a cover meter.

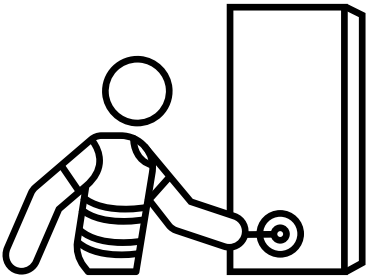


Digital image output from thermal camera.

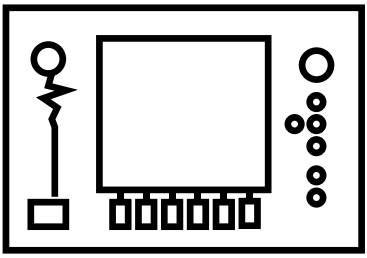
High-frequency impulse radar (up to 0.5m depth) to scan reinforcement.



Measuring thickness of a metal object using an ultrasonic thickness gauge.



Metal detector to scan a concrete-encased steel column.



Impulse radar real-time output data showing location of reinforcement.

Structural Element	Material	Non-destructive technique	Output
Floors	Concrete	Impulse radar (High/ Low freq 0.5/1.0m dp)	Arrangement of reinforcement & spacing, filler joist locations & centres. Not suitable for determining reinforcement bar sizes.
		Cover meter	Map the arrangement of reinforcement & provide spacing dimensions (filler joist locations & centres), rebar dims & local depth of cover.
	Hollow clay pots	Thermal imaging camera	Immediately identifies material boundaries based on temperature differences. Allows spacing & locations to be determined. Laser pointer integrated within camera can also be used to mark & measure dims.
	Timber	Impulse radar (High frequency)	Map joist locations & centres but not sizes.
		Lifting floorboards / drill small holes	Cross sectional dimensions.
Walls	Masonry	Impulse radar (Low freq)	Wall thickness & material type. Low frequency best for finding the back of the wall. Calibration based on wall with access both sides.
Roof	Timber	Thermal imaging	Rafters / joists located and centres estimated.
Beams & columns	Concrete encased	Metal detector (small / med / large heads)	Sound indicates presence of metal. Small head has smallest range but is most sensitive.
	Steel	Ultrasonic	Web & flange thickness particularly when web accessible one side only
		Vernier	Flange thickness, manual measurement.

05

Inventory + Structural Sketches

Once a basic measured survey is available and archive information has been sourced following the desk study and non-intrusive investigations, an inventory of materials and elements can be created.

Supplied as a simple Excel spreadsheet, with yellow highlighted columns indicating the data, included in the material passports template.

This is accompanied by structural sketches indicating locations of the structural elements with any IDs referenced in the inventory.

The inventory is used to:

1.
Measure material quantities and establish the type of structural elements available for Reuse.

2.
Help select reclamation markets to target (based on aggregated inventory data).

3.
Feed into the BIM model of the existing building and material passports for individual elements.

EW ID	ID	Material	Element Type	Element	Section	Mass/Metre	Width (mm)	Depth (mm)	Length (mm)	Area (m2)	Vo (m
34NR-GF-SB-001	SB-X-00001	Steel	Beam	Steel Beam	305x165x40 UB	40.3			3900		
34NR-GF-SB-002	SB-X-00002	Steel	Beam	Steel Beam	305x165x40 UB	40.3			3700		
34NR-GF-SB-003	SB-X-00003	Steel	Beam	Steel Beam	305x165x40 UB	40.3			3600		
34NR-GF-SB-004	SB-X-00004	Steel	Beam	Steel Beam	356x171x45 UB	45			1600		

Key

- Load-bearing brickwork
- Partitions
- Steel beams
- Concrete
- Timber
- Blockwork
- Slate
- Roof
- Padstones
- Steel columns
- Reinforced concrete columns with plinth (TBC)
- GPR vertical investigations
- GPR horizontal investigations

olume n3)	Weight (kg)	Tensile Strength (N/mm2)	Steel Grade	Structural Load-bearing	Structural Stability	Others	Existing Method of Fixing	Data Source	Comments
	157	265	S275	Y	N		Bolted	Estimated (visual inspection)	
	149	206	S275	Y	N		Welded	Estimated (visual inspection)	
	145	341	S355	Y	N		Bolted	Estimated (visual inspection)	
	72	271	S275	Y	N		Bolted	Estimated (visual inspection)	

06

Practical Deconstruction

Conversations with various demolition contractors have identified a series of issues within the current demolition industry that act as barriers to making deconstruction and material Reuse the norm.

A five-point plan to address these barriers is outlined here:

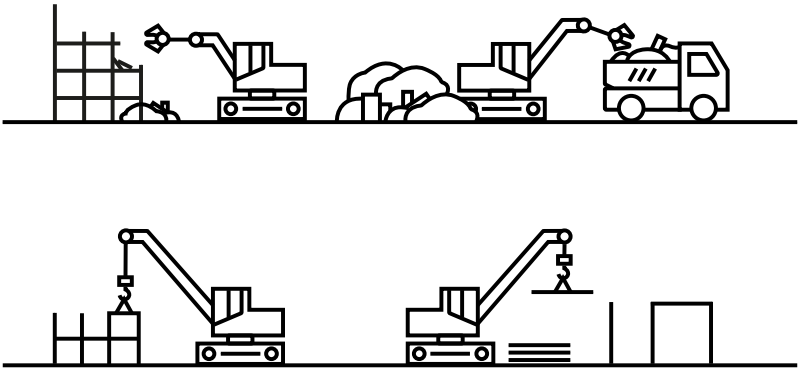
1.
Early involvement of demolition specialists.

2.
Better specification of client objectives with respect to material Reuse.

3.
Rewrite demolition contracts to incentivise demolition contractors.

4.
Improve recertification of and warranties for reclaimed materials.

5.
Legislation to disincentivise cheap materials.



1

Early involvement of demolition specialists

Reuse project: First contact with demolition contractor

0

Strategic Definition

1

Preparation & Briefing

2

Concept Design

3

Spatial Coordination

4

Technical Design

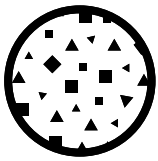
5

Manufacturing & Construction

Typical project: First contact with demolition contractor

Recommend demolition engineer / specialist joins design team

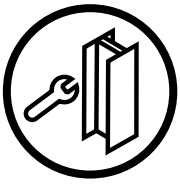
2



Better specification of client objectives with respect to material Reuse

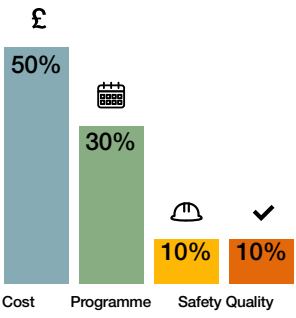
“Is there any reason why you can’t unbolt a steel frame rather than cut it ?”

“No technical reason, it’s just we’re never asked to”

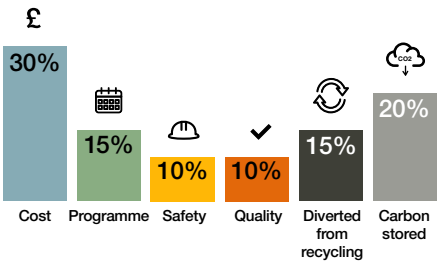


3

Rewrite demolition contracts to incentivise deconstruction



Current Situation



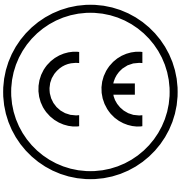
Tender breakdown to incentivise contractors

4

Improve re-certification and warranties for reclaimed materials

—Currently re-certification of reclaimed materials is rare.

—Re-certification and warranty is needed to improve uptake of second-hand materials.



Options

—Salvage merchants undertake role.

—Engage with investigation companies willing to enter into collateral warranties based on testing.

—Incentivise manufacturers to take responsibility for repair and refurbishing. Difficult for commoditised materials.

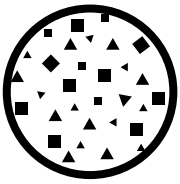
5

Legislation to reduce the impact of cheap materials

—Cheaper to buy new than salvage materials.

—Unsustainable for a single client to bear the cost.

—UK legislation required to incentivise second-hand markets.



07

Reuse Feasibility

The main elements of our buildings are categorised according to the RICS NRM: New Rules of Measurement into: substructure, superstructure, internal finishes, fittings, furnishings and equipment, services and external works.

The table (shown right) indicates an example feasibility of reusing building elements and the associated environmental benefits that this entails as assigned by Addis B (2006).

This is indicated with three levels – low, medium, high. The specific level for each individual building element should be indicated in the inventory once the investigations are completed (condition, performance, grade, etc.). These can then be used to identify the opportunities for reclamation.

Similar scores have been proposed by others. For example, some classify the materials with Reuse potential in two different categories. Category A for those elements that are commonly reclaimed, in sufficient quantities and in good condition.

Category B is for elements that are available in the Reuse market, but the quantity or quality is not sufficient to be of interest for resellers. However, they are considered easy to be removed and with the Reuse potential for small contractors, etc.

Another example is a grading system that specifies the Reuse, recycle, recovery and landfill potential in percentages.

Category A Materials	Category B Materials
Bricks	Structural timber
Steel beams & Columns	Roofing slates
	Sanitary Equipment
	Tiles
	Wooden Flooring
	Lighting
	Doors
	Technical installations e.g. ventilation plant
	Other finishing elements

Reuse Potential/Environmental Benefit

- High
- Medium
- Low

	Reuse in-situ		Reclaimed for Reuse	
	Potential	Benefit	Potential	Benefit
Substructure				
Pad & Strip Foundations	High	High		
Superstructure				
Frame - Structural steel framing	High	High	High	High
Frame - Wrought-iron columns and beams	High	High	Low	Low
Upper floors - Timber floor beams	High	High	High	High
Upper floors - Precast concrete/ceramic blocks	High	High	Medium	Medium
Roof - roof structure - Traditional timber framing	High	High	High	High
Roof - roof covering - Slate/tile cladding/roofing	High	High	High	High
External walls - Masonry walls - brickwork (lime mortar)	High	High	High	Medium
External walls - Masonry walls - brickwork (cement mortar)	High	High	Low	Low
External walls - Masonry walls - blockwork (cement mortar)	High	High	Low	Low
Windows - Timber windows/rooflights (glazed)	Medium	High	High	Medium
Windows - Steel/aluminium windows/ rooflights (glazed)	Medium	High	High	High
External doors - Glass doors	High	Low	High	Low
External doors - Architectural ironmongery	High	Low	High	High
Internal walls and partitions - Rigid sheet construction	Medium	Medium	Medium	Medium
Internal walls and partitions - Plasterboard construction	High	Medium	Low	Medium
Internal doors - Wooden doors	High	Medium	High	Medium
Internal finishes				
Wall finishes - Plastered coatings	Medium	Medium		
Floor finishes - Rigid tiles	Medium	Medium	Low	High
Floor finishes - Carpet (fitted)	Low	Low	Medium	Medium
Floor finishes - Timber boards	High	Medium	High	Medium
Ceiling finishes - Suspended ceiling (tiles)	High	Medium	Medium	Medium
Services				
Sanitary installation - Drainage pipes	Medium	High		
Sanitary installation - Toilet, sinks and baths	Medium	Medium	Medium	Medium
Water installations - Water supply/storage/ distribution	High	High	Medium	Medium
Space heating and air conditioning - Distribution (ducting)	Medium	Medium	Low	Medium
Electrical installations - Distribution cable	Medium	Medium	Low	Medium
Electrical installations - Terminal devices (sockets, etc.)	Medium	Medium	Medium	Medium
Electrical installations - Terminal devices (luminaires)	Medium	Medium	Medium	Medium
External Works				
Fencing and barriers	High	Medium	Medium	Medium

08 Reuse Evaluatio Materials + Proc

Existing building Identify and classify the different types of building components, materials and products	Acceptability criteria	Deconstruction feasibility
1. Substructure		
2. Superstructure – Frame – Upper floors – Roof – Stairs and ramps – External walls – Windows and external doors – Internal walls and partitions – Internal doors	– Acceptability criteria depends on the structural material – The quality of tiles and slates can be assessed visually – Waterproofing not suitable for Reuse (e.g. roof waterproofing products) – Performance of glass unit (transmission performance, reflectivity and emissivity) – Type and material of window frames	– Deconstruction criteria (e.g. type of connections) – Usually building envelope components such as roofing tiles and slates; brick and stones used in façades, can be easily removed without little or no damage – In principle, modern cladding systems could be carefully removed,but the non-standard sizes and fittings hinders its Reuse – Timber studs from partitions could be disassembled – Cast-iron spiral staircases are easy to remove
3. Internal finishes – Wall finishes – Floor finishes – Ceiling finishes	– Visual condition or damage to tiles, flooring, suspended ceilings, etc. – Condition criteria for masonry partitions less constrained than for exposed masonry	– Supporting framework, ceiling tiles and raised access floors can be removed with little damage – Floor covering can be removed with relatively little damage (not the case for screed floors) – Tiles fixed with modern cements or chemicals adhesives are likely to be damaged – Rigid panels will most likely be damaged beyond Reuse during demolition
4. Fittings, furnishings and equipment	– Visible damage and condition of furniture	
5. Services – Sanitary installations – Services equipment – Disposal installations – Water installations – Heat source – Space heating and air conditioning – Ventilation – Electrical installations – Fuel installations – Lift and conveyor installations – Fire and lightning protection – Communication, security and control systems – Specialist installations	– M&E equipment to be checked for energy efficiency and obsolence – Energy efficient HVAC makes greater impact on carbon emissions over the whole life than equipment embodied energy – Obsolence is a major issue for items such as motor control centres and control systems (BMS). Controls are in constant improvement	– Building services usually easy to remove – Cable trays are easily dismantled – Underfloor heating and cooling system pipes embedded within concrete screed are difficult to remove without damage – Pipes or electric heating elements laid directly under floorboards are easy to demount – Ductwork is difficult to demount as it can be easily damaged – Fan-coil units are easy to move but items that could be easily damaged should be carefully removed – The removal of some sanitary, laundry and cleaning components is difficult without damage
6. External works		– Most paths and rods using slabs, setts, cobbles, and interlocking paving bricks and blocks are easy to lift

on Building ducts

The below diagram shows the key process considerations of reclamation for the different building components, materials, and products.

Although these are not exhaustive, it provides examples that are useful to generate an overall picture of the reclamation challenges and opportunities.

Condition, performance and grading assessment	Reconditioning	Reuse in-situ Reclamation market / salvage yard Recycling
Pad, strip and raft foundations; piled foundations and ground retention is generally limited to Reuse in situ and subjected to the assessment to ensure the performance for their intended use	Assessment of the condition of galvanised steel screw-piles for Reuse	– Galvanised steel screw-piles can be removed and Reused – Concrete can be recycled as aggregate for in-situ concrete work
– Evaluation of structural components and materials (declaration of material properties) and condition assessment – Appraisal of the envelope – Establish facade construction and how it is connected to the rest of the building – Testing (e.g. thermal properties of glass), repair and refurbishment – Feasibility of refabrication (e.g. annealed window glass can be cut, but heat-treated, toughened or tempered glass cannot be cut) – Assessment of the condition of the frames, handles, stays and locks in windows – Evaluation of windows against current standards to define if upgrading is needed – Testing of individual windows for air-tightness, water penetration or acoustic performance, if required	– Grouping/sorting & reconditioning – Considerations for building envelope components: • Appearance • Structural requirement • Ingress of water and airtightness • Thermal performance • Solar performance • Condensation • Acoustic performance • Fire resistance • Durability (corrosion) – Some materials such as window frames, doors and iron radiators can be 'sold as seen' and refurbished by the buyer – so no reconditioning	– Structural materials can be Reuse in-situ, on-site or send to resellers – Precast concrete (potential of being salvaged, but it is not common) – Concrete (is normally recycled: crushed and used for hardcore) – Architectural salvage market for old bricks, roof tiles and panels of stone is relatively well established, there is also salvage market for: • Complete windows; domestic doors • Decorative joinery, banisters and newel posts of timber staircases • Cast-iron spiral staircases; balconies and balustrades made of cast or wrought iron – Storage issues: • For façades, reclamation companies needs to wait for a buyer who wants the style and size • Some cladding elements may not be stored flat, in piles or stacked resting on their edges
– Timber floors should be checked for rot and infestation	– In principle, suspended ceilings could be refurbished and made available for Reuse, but there is no significant market for this	Architectural salvage market available for: – Wood panelling from high-quality old buildings – Floor covering (tiles, bricks, timber floors, carpet, etc.) – Timber floors (hardwood – oak, maple and teak)
– Establish the condition, performance and safety of equipment and check compliance with current regulations	– Reconditioning of furniture – Cleaning of all equipment	Architectural salvage market for – Furniture (domestic, small-scale commercial use) – Catering and cleaning equipment
– Appraisal of existing building services to check if they meet the performance targets – Assess if refrigerant in a product is on the banned list (European Directive 2037/2000) – Establish the duty, condition and design life of pumps – Check design capacity of heat exchangers – Testing of HVAC plants – Testing of electrical equipment for legislative compliance and adequate operation and capacity – Switches and sockets requires electrical testing after salvage – Test sanitary equipment for water regulations	– Usually, salvage yards do not deal with working equipment. Manufacturers or companies specialised in reconditioning are needed – Boilers can be reconditioned by replacing wearing parts and cleaning other parts – Heating and cooling pipes needs to be cleaned, pressure tested and rewound – Recommissioning and recharging of units with an environmentally friendly refrigerant – Replacement of coolant in old oil-cooled transformers – Cleaning and refurbish (and possibly re-enamelling) of sinks, baths and sanitary appliances	M&E Reuse market: – Generators, motors, large electrical cables, fan-coil units and transformers; Pipes and fittings; Refrigeration plants; Transformers; Boilers (some companies hire boilers) M&E components for which there is no Reuse industry: – Air-conditioning units – Transport services equipment (e.g. lifts) M&E recycling market: – Building services equipment can be disassembled at their end of life and the high-value metals and plastics put back into the supply chain for recycling – Lamps are not usually Reused, but there is an established industry for recycling the constituent materials of luminaires
– Structural and safety testing of outdoor/street furniture and equipment		

Reuse Evaluation Steel + Concrete

1

Acceptability criteria of steelwork / steel members

- Not subjected to fire or impact
- No signs of plastic deformation
- Not subjected to significant strains
- Demolition contractor input for careful deconstruction

2

Initial assessment

- Collection of data of the existing structure (data available & archive information)
- Preliminary visual inspection: Assessment of exposed steel, & assessment of steel behind finishes or concrete encased steel
- Initial inventory of steel members

Steelwork erected before 1970

Carry out initial assessment. If the structure is not significantly over-stressed, unsatisfactory or unsound state, then carry out testing (following the guidance of SCI P138)

Tensile tests - sampling & statistical analysis (refer to SCI P138):

- Number of samples: six samples (unless the material is very variable)
- Sampling strategy to prevent bias

Steelwork erected after 1970

Follow SCI P427 protocol

Steelwork erected after 2014 (unused & well documented)

Material properties can be assumed appropriate – in line with SCI P427 & according to BS EN 1090-2 clause 5.1

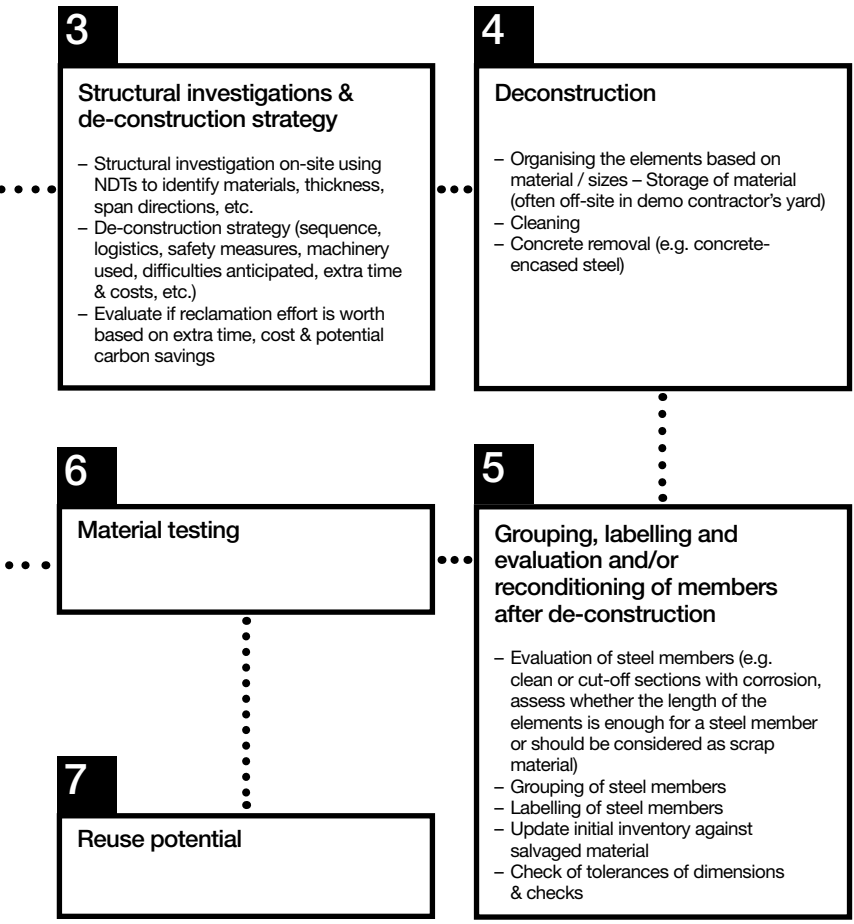
This chart provides guidance to assess the suitability of salvaged steel and concrete for Reuse.

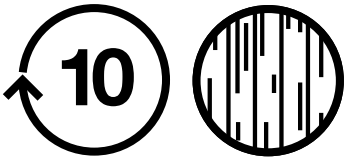
Steel

For steel, the key protocol is SCI P427 but this doesn't allow pre-1970s steelwork to be Reused so we've proposed waiving some of the acceptability criteria.

Concrete

Concrete including pre-cast, currently gets crushed and used as hardcore (downcycled). Can we look to Reuse as RC beams and columns?





Reuse Evaluation Timber

1

Identify timber constructions within the building

- Timber building
- Timber floorboards, walls, roofs, beams and columns

2

Evaluate the accessibility, conditions & factors that may affect the assessment in-situ

8a

Reuse of timber members & timber floor-boards in construction

Whole timbers

7 Sorting & grouping

Timber Fragments

Below offers a guide to assess the suitability of salvaged timber for Reuse.

Reuse potential depends on:
- —Its condition.
- —Presence of hazardous or toxic coatings (e.g. arsenic).
- —Proposed purpose.

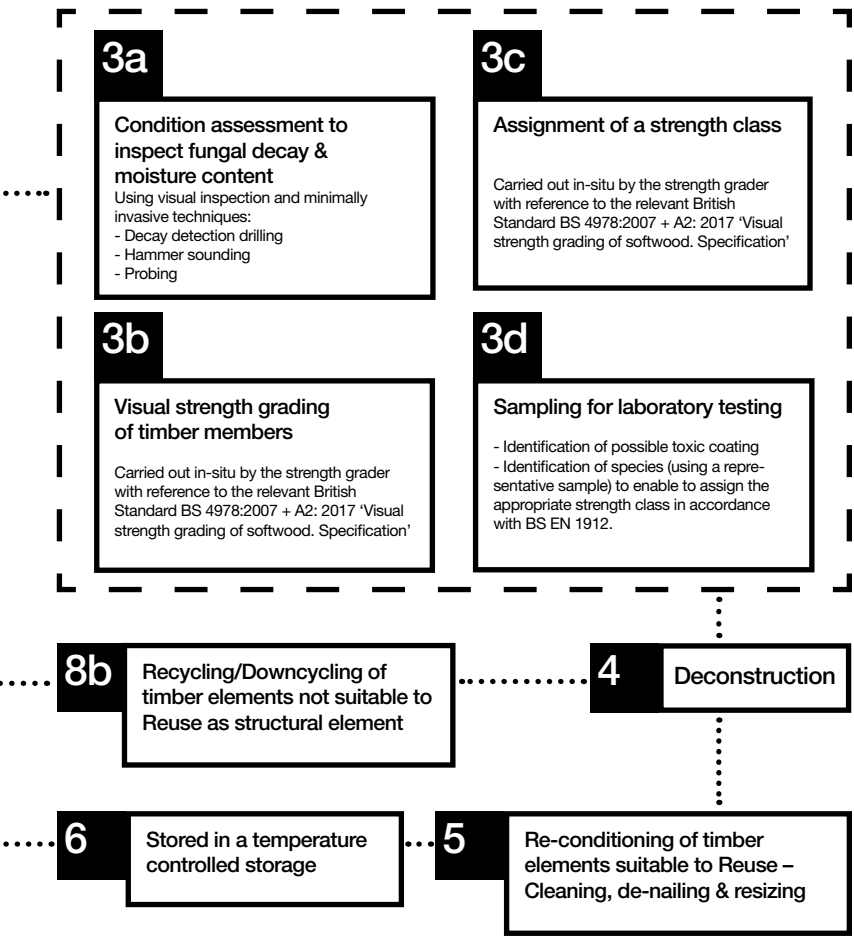
Condition assessment looks for:
- —Fungal decay.
- —Wet or dry rot.
- —Insect infestation.
- —Moisture content.

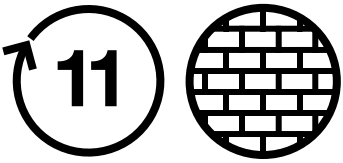
Treatments can then be recommended.

Testing and grading:
- —Reagent tests to identify potentially hazardous or toxic coatings & paints such as lead paints.
- —Visual strength grading (a strength grader needs to see three sides of the timber).
- —Identify species using small splinter samples approx 10mm by 10mm.

Deconstruction strategy:
- —Plan for reconditioning (cleaning, resizing) timber elements.
- —Appropriate storage (temperature / moisture control).
- —Sort & group based on type of timber element.

Second-hand markets:
- —Well established for hardwood.
- —Softwood Reuse is rare due to the labour cost of salvage vs low cost of new softwood.





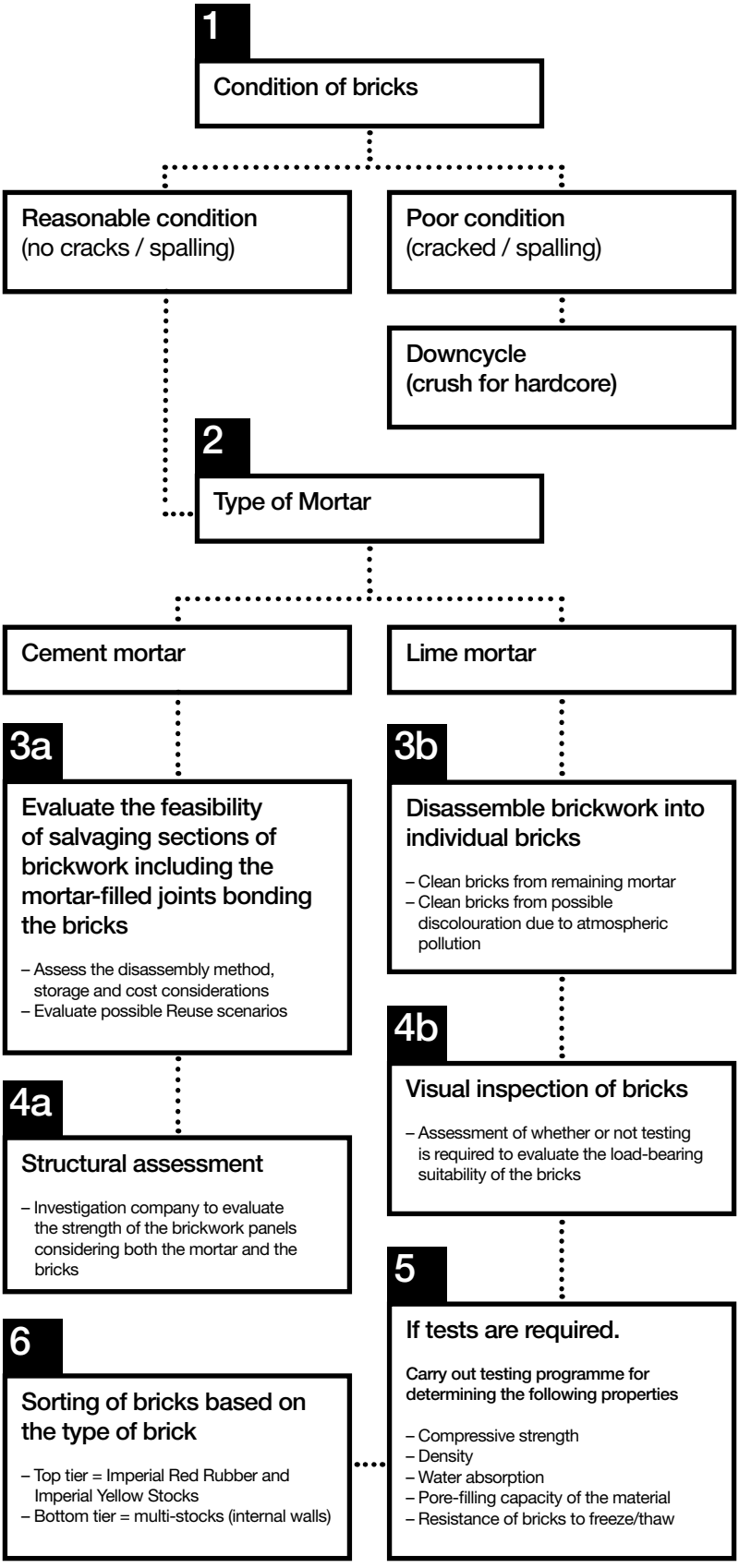
Reuse Evaluation Masonry

The key to reclaiming masonry is the mortar used to bond it together. Brickwork constructed using traditional lime mortar can be dismantled into individual bricks, cleaned and salvaged easily.

Bricks set in cement mortar or modern lime mortar don't clean up well and generally won't be salvaged.

Suitability for Reuse can be assessed by visual inspection or testing to confirm density, water absorption, etc.

For brickwork using cement mortar it might be better to salvage complete sections of wall for Reuse as a new wall or facade.


1
Condition of bricks
Reasonable condition
(no cracks / spalling)
Poor condition
(cracked / spalling)
Downcycle
(crush for hardcore)
2
Type of Mortar
Cement mortar
Lime mortar
3a
Evaluate the feasibility of salvaging sections of brickwork including the mortar-filled joints bonding the bricks
– Assess the disassembly method, storage and cost considerations
– Evaluate possible Reuse scenarios
3b
Disassemble brickwork into individual bricks
– Clean bricks from remaining mortar
– Clean bricks from possible discolouration due to atmospheric pollution
4a
Structural assessment
– Investigation company to evaluate the strength of the brickwork panels considering both the mortar and the bricks
4b
Visual inspection of bricks
– Assessment of whether or not testing is required to evaluate the load-bearing suitability of the bricks
5
If tests are required.
Carry out testing programme for determining the following properties
– Compressive strength
– Density
– Water absorption
– Pore-filling capacity of the material
– Resistance of bricks to freeze/thaw
6
Sorting of bricks based on the type of brick
– Top tier = Imperial Red Rubber and Imperial Yellow Stocks
– Bottom tier = multi-stocks (internal walls)

12

Reuse Alternatives

The Reuse protocol for the key structural materials presented in the previous pages is mostly focused on the Reuse of structural materials after reclamation.

The Reuse of elements in-situ is inherently different as it does not involve the removal of members and is generally considered more commonly applied in practice than reclamation.

For Reuse in-situ, the complexity of the evaluation procedures increases in relation to how exposed the structural members are. The collection of the testing samples is more complex as well as the evaluation of the condition of the members and their connections (including evaluation of welding).

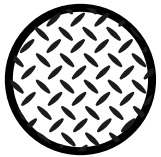
For salvaged elements, the extra time and cost along with the increase of logistics due to deconstruction should be taken into consideration.

The adequate Reuse of elements must be evaluated based on several aspects such as the proposed project, utilisation ratios of the elements, deconstruction feasibility, difficulties of in-situ sampling and testing and embodied carbon saved.

Shown right, we highlight some of the differences between Reuse in-situ and salvage for Reuse elsewhere of the four structural materials presented previously.

The different Reuse alternatives identified are:

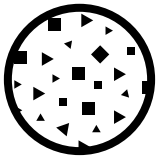
—Reuse in-situ.
—Reuse on-site (same-site Reuse).
—Site-to-site Reuse.
—Reuse via materials supplier.



Steel

Reuse in-situ
Increases the complexity of collecting testing samples; the steel members may not be fully utilised, so there is potentially spare capacity, which can be easily assessed by comparing existing loading with proposed loading. Absolute capacity checks are not always required. For connections, the condition and strength of the connections are to be checked.

Salvaged for Reuse elsewhere
Increased time and cost due to deconstruction should be taken into consideration. Connections are usually not salvaged for Reuse. An exception is for whole steel frames that can be dismantled and assembled on a new site. In general, assessing the condition of these connections would not represent an issue as all the finishes will have to be removed before dismantling exposing the connections. A full suite of testing is recommended for salvaged steelwork as final use is unknown and it may be designed for 100% utilisation in future.



Concrete

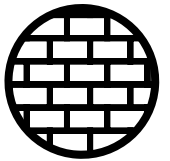
Reuse in-situ
Structural investigations to evaluate the condition and capacity of concrete elements.

Salvaged for Reuse elsewhere
Unlikely to salvage concrete elements as generally crushing is the main option.

Timber

Reuse in-situ
Visual grading in situ may be hindered by accessibility to elements and opaque coatings.

Salvaged for Reuse elsewhere
The high labour costs in the UK makes reclaimed timber elements expensive.



Masonry

Reuse in-situ
Samples for testing may need to be taken to carry out an adequate structural appraisal of the masonry structure. Alternatively, in-situ testing may be considered. Reuse can also be assessed based on comparing existing and proposed loads.

Salvaged for Reuse elsewhere
Risk of theft and damage during disassembly and transportation.

What Next?

This is just the beginning of a process, a practical guide created by Engineers and clients who manage, commission and build.

How can we take this into the day-to-day until it becomes the norm?

We see four pathways to explore:

1. Financial Incentives

The introduction of the landfill tax shifted construction and demolition waste away from landfill.

We now need to create new financial incentives or disincentives to shift away from recycling to maximise the service life of building materials.

We need to promote the establishment of reclamation markets and new UK legislation to incentivise deconstruction and reclamation to enable a true Circular Economy in the construction sector.

2. Research

Further research to establish better value-based metrics for valuing existing building elements are needed. These metrics could incorporate aspects such as resale value, embodied carbon, deconstruction time and market interest.

3. Incentivise Deconstruction

Investigate better models for tendering demolition contracts to incentivise deconstruction over demolition.

4. Legislation

Consider working with the Government to develop legislation that incentivises Reuse of materials over demolition.

This could be in the form of ‘carbon tax’ on new developments which is collected in a central fund and used to help fund the establishment of second-hand markets.

Another option could be the shift of tax revenues from labour tax to natural resources’ tax as proposed by the Ex-tax campaign, adding value to materials and therefore promoting their Reuse.

If you'd like to discuss this guide or help us go Full Circle to Reuse, you can get in touch with us at Elliott Wood through the channels below.

Penny Gowler
p.gowler@elliottwood.co.uk

Gary Elliott
g.elliott@elliottwood.co.uk

Telephone
+44 (0)20 7499 5888

Full Circle to Reuse
by Elliott Wood and
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A response to ETHICS
A manifesto for change set out by Elliott Wood that focuses on Education, Technology, Healthcare, Infrastructure, Culture and Sustainability.

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