GBI Professional Series 2014
Workshop on Waste Management &
Responsible Sourcing :-
Reducing Waste Through Architecture
Design

Ar Alice Leong Pek Lian
MGBC

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Real Estate Sector’s Global Impact

Buildings are responsible for 40% of world’s
global greenhouse gas emissions

Buildings use 12% of the world’s water

Buildings are responsible for
40% of solid waste generation globally

Air quality in buildings typically
contains up to 5x more pollutants than
outdoor air

Buildings use 1/3 of world’s resources

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Real Estate Sector’s Global Impact

- Our impact on the planet is beyond carbon
- 13 million hectares of the world’s forests are lost each year.
- 30% of earth’s land surface has been converted for agriculture and urbanisation.
- 30% of fresh water diverted for human use.
- Half the world’s reef building corals lost.
- Atmospheric CO2 levels up by 35% since industrialization
- Every year we are extracting and distributing in the biosphere toxic minerals which the earth had contained over it’s first billion years, including 12,750 tonnes of Cadmium, 3 million tonnes of Lead, 39,000 tonnes of Uranium, and 100,000 tonnes of Mercury since 1981.

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Less Waste, Sharper Design

Sustainability has risen rapidly up the construction agenda over the past few years. Architects play a key role in helping to deliver projects that are sustainable in terms of their environmental, social and economic impacts. One important impact is waste, particularly waste arising during construction.

The Architect has a decisive and very important role to play in helping to reduce waste in construction through design.

A design decisions can make a significant and positive difference, not only through reducing environmental impact but also making the most of resources.

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GBI RNC TOOL

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### GBI NRNC RETAIL TOOL

**DETAIL ASSESSMENT CRITERIA**
**SUMMARY OF FINAL SCORE**

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### GBI NREB RETAIL TOOL

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### GBI NRNC HOTEL TOOL

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# GBI NRNC Resort Tool

## Detail Assessment Criteria

**Summary of Final Score**

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# GBI NREB Resort Tool

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GBI INC TOOL

**DETAILED ASSESSMENT CRITERIA**

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GBI INTERIOR TOOL

**ASSESSMENT CRITERIA**

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**Total = 14 Points**

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White boxes highlight the areas where Architects can have a significant impact.

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It is important that Architects also adopt the *waste hierarchy* that focuses initially on reducing waste, as this is where potentially larger impacts can be made.

The efficient use of materials reduces the quantity of materials used in the first instance, lowers the material purchasing costs, minimizes waste and eliminates the need for subsequent handling and disposal costs.

Developing a strategy to reduce waste is one of the most effective ways to address waste in construction.

Once effective waste reduction measures are in place, it is then more appropriate to consider how to reuse, recycle, recover or finally dispose of waste in a structured way.

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5 key principles that Architects can use during the design process to help in reducing waste:

- Design for Reuse, Recovery & Materials Selection;
- Design for Off Site Construction;
- Design for Materials Optimisation;
- Design for Waste Efficient Procurement; and
- Design for Deconstruction and Flexibility;

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Site analysis & site is one of the very first activities carried out prior to design.

The reuse of buildings (if any on the site, including parts of buildings) and or existing materials to accommodate the client’s requirements should be considered from this very early stage.

If the decision is made that only a new building will satisfy the client’s requirements, demolition and site clearance consequentially follow.

When opportunities exist for reusing materials and/or components, these will need to be reviewed, to ensure that they meet the required functionality of the new building design.

If there is no such opportunities exist, then the Architect should advise the client and/or the demolition contractor as appropriate and promote good practice in the demolition to ensure maximum recovery of materials through recycling.
**Design For Reuse, Recovery & Material Selection**

**Questions:-**

- Can materials from demolition of the building or other phases be reused in the design?
- Can reclaimed products or components be reused?
- When materials are reused, can they be reused at their highest value?
- Can any excavation materials be reused?
- Can cut and fill balance be achieved? How can it be optimized to avoid removal of spoil from site?

**Design For Reuse, Recovery & Material Selection**

**Architect’s Action :**

- Create design solutions that minimize waste and use resources efficiently.
- Identify for clients and contractors the best opportunities to reduce waste and use more recovered material, structures.
- Measure the potential improvement at project level.
- Support design teams in broadening their knowledge of resource efficient design.
- Report annually on overall corporate performance (this particularly applies when architects and consultants are signatories to construction commitments)
Design For Reuse, Recovery & Materials Selection

Architect’s Action (cont.):

- If materials are reused or recycled, discuss further with other consultants whether they require testing, refurbishment, treatment or certification etc.

- Discuss the appointment and requirements of the demolition contractor with the client to maximize reuse, recovery and recycling opportunities.

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Reused Materials – What will NOT be Considered BUT Can Be Reused

- Hoarding Sheet
- Temporary Site Cabins
- Sheet Piles
- Wall Hangings
- Earth/Soil

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Permeable Material

Rainfall picks up contaminants from impervious surfaces such as solid surface asphalt, concrete streets, driveways, and other pathways, which further contribute to water pollution.

In comparison, using permeable materials, it allows natural filtration and reduces the costs associated with adding storm water management systems.
Permeable materials have **porous surfaces** that mitigate and control stormwater runoff by allowing water to pass through into the underlying soils.

Maintain a high-level of aesthetic quality. Most of these materials are also more reflective, which can help decrease the heat island effect.

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Design For Reuse, Recovery & Materials Selection

Solar Reflectance: the fraction of solar energy that is reflected by the roof

Thermal Emittance: the relative ability of the roof surface to advect absorbed heat

Same heat is absorbed by the roof and transferred to the building below

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Design For Reuse, Recovery & Materials Selection

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Certified woods - harvested woods that originate from responsibly managed forests. These woods are certified through an independent organization that issues standards for sustainable forest management.
Design For Reuse, Recovery & Materials Selection

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## Design For Reuse, Recovery & Materials Selection

### Reuse of Materials

#### Worked Example (Sample)

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<td>Salvaged Wood Floor</td>
<td>Antara Kita Enterprise</td>
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<td><strong>Total Construction Material Cost</strong></td>
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<td>% of Reused Materials</td>
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The potential to use Off Site Construction should be made at the earliest stage of design because of its impact upon:

- space planning, especially structural and planning grids;
- structural design/system selected;
- project buildability;
- procurement routes; and
- consideration of how aesthetics are affected by Off Site Construction.

For smaller scale systems and/or components, usually procured through specialist subcontractors, it is likely that the Architect will consider those elements suitable for Design for Off Site Construction during later design stages.

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Benefits of off site factory production in the construction industry are:-

- **Well documented** (included the potential to considerably reduce waste, especially factory manufactured elements and components are used extensively).

- Has potential to significantly change operations on site.

- Reducing the amount of trades and site activities.

- Changing the construction process into one of a rapid assembly of parts that can provide many environmental, commercial and social benefits.

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(continues)

- Reduced construction related transport movements; Improved health and safety on site through avoidance of accidents;

- Improved workmanship quality and reducing on site errors and re-work, which themselves cause considerable on site waste, delay and disruption; and

- Reduced construction timescales and improved programmes.

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Questions:

- Can the design or any part of the design be manufactured off site?
- Can site activities become a process of assembly rather than construction?

Architect’s Action:

- Study the impact of Off Site Construction solutions on the building design, cost and programme.
- While conducting the site investigations, identify any site conditions that either facilitate (easy access or use of local manufacturer) or impede (access/traffic problems, neighbours, air rights issues, buildability e.g. craneage) the use of Off Site Construction.
- While undertaking the necessary consultations assess, study the benefits or disadvantages to the use of Off Site Construction as opposed to traditional on site construction.
- Discuss with other design team consultants the practicability, benefits, and disadvantages of Off Site Construction and alternative on site construction methods.
- Assess the cost of any testing and certification, if required.
Modular building is constructed off-site with all materials pre-built with pre-determined codes and sizes.

The off-site assembly approach to building a data center offers a sustainable alternative to site-based data center construction and a more resource-efficient way to produce green data center facilities.

Prefabrication is the act of constructing elements off site at a specific manufacturer and transporting them onto site for easier assembly.
Design For Off Site Construction

An off-site factory for construction allows to reduce waste and use fewer materials overall, which results in approximately 50% to 75% less waste during construction.

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Design For Materials Optimisation

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Design For Materials Optimisation

During design stage, it is the Architect’s duty in adopting a design approach that focuses on **materials resource efficiency**, so that less material is used in the design, and/or less waste is produced in the construction process, without compromising the design concept.

- minimization of excavation;
- simplification and standardisation of materials and choices; and
- dimensional coordination.

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In order to assess the best project opportunities for material optimization, the following key questions need to be asked:

- Can the design, form and layout be simplified without compromising the design concept?
- Can the design be coordinated to avoid/minimize excess cutting and jointing of materials that generate waste?
- Is the building designed to standard material dimensions?
- Can the range of materials required be standardised to encourage reuse of offcuts?
- Is there repetition & coordination of the design, to reduce the number of variables and allow for operational refinement (e.g. reusing formwork)?

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Design For Materials Optimisation

Design Details:

- Consider structural solutions that use less material and simplify the structural solutions as much as possible (e.g. use concrete solutions like post tensioning instead of cast in situ reinforced concrete).
- Group functions with similar special requirements so that the building is composed of repeatable special elements and the overall design is simplified.
- Consider the design of the building and how it might be simplified in terms of:
  - building form;
  - the structural system;
  - the building services; and
  - construction sequence/methodology.

Design For Materials Optimisation

Design Details (cont.):

- Investigate opportunities to avoid excavation (e.g. consider important aspects like orientation, existing services, set the key levels in relation to site contours and ground conditions etc).
- Study the extent of excavation (e.g. whether full or part basement is needed).
- Review foundation solutions to ascertain if options such as rotary or displacement piles, (rather than replacement) can be considered.
- Discuss and agree with the client and design team the implication of minimization of excavation solutions (impact on the building design, functionality, cost, programme aesthetics etc).
Design Details (cont.):
- Review the necessity for all finishes.
- Optimize tile layout any size to reduce cutting and offcuts.
- Use new thin insulations to reduce depth of wall thickness and maximize overall building net/gross areas.
- For odd plan shapes consider the use of formless materials for finishes rather than formed materials (e.g. latex screed rather than vinyl tiles).
- Use full height doors or doors with fan lights above (i.e. to ceiling) to avoid cutting plasterboard sheets.
- Ensure door details have full returns to avoid plasterboard and angle beads forming opening returns.
- Use thicker plasterboard sheet rather than doubling up on board.
- Ensure sound insulation is not over-specified for the required purpose of the room/building, so avoiding unnecessary use of materials.

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Design For Materials Optimisation

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Design For Materials Optimisation
Design For Materials Optimisation

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Design For Materials Optimisation

Design For Waste Efficient Procurement

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Design For Waste Efficient Procurement

Architects have considerable influence on the construction process itself, such as:

• **Design** (e.g. designing building elements which can be constructed efficiently)

• **Specification** (e.g. tighter specifications of work procedures to avoid waste and allow use of offcuts; provide protection to fragile materials to minimize damage on site; etc); and

• **Contracts** (e.g. encourage early contractor involvement)

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Design For Waste Efficient Procurement

Architects need to consider:

• how work sequences affect the generation of construction waste.

Once work sequences that could cause site waste are identified and understood, they can often be ‘designed out’.

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Again, this is not easy to consider detailed construction alternatives at early stage.

However, as mentioned before, it is important at these stages to agree with the client and other consultants that Design for Waste Efficient Procurement is part of the overall strategy, so that all parties are committed to including it later in the design process.

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**Architect’s action:**

- Discuss appointment and requirements of demolition contractor with the client to maximize reuse, recovery and recycling.

- Consider the implications the design solution to construction activities (e.g. specifications and contracts).

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This could be the greatest difficulty!
Time frame involved!
Buildings are sold and re-sold over time, the connection between the original client and designer and the ultimate beneficiary of Design for Deconstruction and Flexibility can become very remote.
Houses, especially often undergo many renovations over their lifetimes, or completed building removal is carried out to make room for a newer home.
Design For Deconstruction & Flexibility

- Architects typically do not design buildings with easy renovation or deconstruction in mind.

- Still, Architects have to understand how materials can be recovered effectively during the life of the building when maintenance and refurbishment is undertaken OR when the building comes to the end of its life.

- It is essential that Architects’ Design for future generations is embedded in the Concept of Sustainability, Design for Reuse & Design for Deconstruction and Flexibility.

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Design For Deconstruction & Flexibility

- Is the design adaptable for a variety of purposes during its life span?
- Can building elements and components be maintained, upgraded or replaced without creating waste?
- Does the design incorporate reusable/recyclable components and materials?
- Are the building elements/components/materials easily disassembled?
- Can a Building Information Modelling (BIM) system or building handbook be used to record which and how elements/components/materials have been designed for disassembly?

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Design for Flexibility & Adaptability

Architects have to understand the ability of a structure to accommodate varied and often unknown future uses and changes with minimum of cost and effort. Strategies shall focus on simplicity, repetition, transparency etc.

Design for flexibility and adaptability is most important for buildings that are likely to undergo changes in use over their lives such as:-

I. office buildings, where tenants frequently change;
II. schools, where changing demographics and educational requirements often lead to school building decommissioning;
III. industrial buildings; and
IV. churches

Design for Adaptability

Some building types are likely to be short-lived and are inherently difficult to adapt, such as commercial strip malls in growing suburbs. These types of structures are best designed simply for deconstruction and material reuse, with sufficient durability to protect the materials through their projected short life.
Design For Deconstruction & Flexibility

Architect's Actions:

- Study and understand what prohibits the large scale reuse of materials and components in the construction industry.
- To provide adequate information, so that future designers have an adequate understanding of the material/ component attributes to facilitate their future reuse.
- Study the application of Design for Deconstruction and Flexibility to major building elements (e.g. structural frame, substructure).
- Design to facilitate future renovations, and eventual dismantlement through deconstruction, a building’s systems, components, and materials will be easier to rearrange, recover, and reuse.

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Architect's Actions:

- Design for durability and adaptability.
- Use fewer materials to realize a design.
- Design for salvaging materials, maximizes the value of a building’s materials help in reducing environmental impacts.

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Architects may discuss with engineers:

I. Designing using higher-than-code-minimum live loads when future uses may require them;
II. Providing redundancy and resiliency in the lateral system in case future adaptations require changes such as new openings in shear walls;
III. Consideration of how the building may be expanded in the future, such as sizing foundations and columns for vertical additions; and
IV. Coordination of the structural system with other building systems to ease future renovation;

Suggestions On Materials Use:

- Use lime mortar or other mortars so that bricks/blocks can be easily dismantled.
- Use mechanical fixings that facilitate deconstruction.
- Avoid gluing and composite materials.
- Specify materials that can be reused rather than recycled.
- Use landscaping materials that can be easily taken up and reused (e.g. grasscrete).
Design For Deconstruction & Flexibility

Suggestions:

- Use structural elements that can be easily disassembled.
- Design foundations that can be retracted from the ground and reused after the service life of the building ceases.
- Use fewer adhesives and sealants. It's easier for construction to salvage useful items and valuable building materials e.g. lumber, fixtures, hardware, and appliances.

Suggestions On Materials Use:

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Design For Deconstruction & Flexibility

ou could build it cheap and fast (like they do in North America) or you could design for deconstruction, as in Alberto Mozó’s design for BIP computers in Santiago, Chile. The entire structure is made from laminated timber and can be dismantled and reconstructed elsewhere.
Design For Deconstruction & Flexibility

You could build it **cheap and fast** or you could design for **deconstruction**. The entire structure is made from laminated timber and can be dismantled and reconstructed elsewhere.

Utilized wood is an incentive for reforestation, since it belongs to the type of wood of a renewable forest, and it is the construction material which produces less carbon emissions for the consideration of our climate changes.

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greenpages malaysia

greenpages malaysia – an information resource directory for green building products and services.

The primary objective – providing info on sustainable building products and services to architects, engineers, developers and others.

A user-friendly, online interface will be consistently updated.

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THANK YOU!

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Extra Guidelines

Design For Reuse, Recovery & Materials Selection

<table>
<thead>
<tr>
<th>Opportunity</th>
<th>Description</th>
</tr>
</thead>
</table>
| Landscaping | Use onsite demolition and excavated material within landscape design.  
  - Drainage lines  
  - Mound features  
  - Reuse or recycle hardscape and softscape if there is on-site storage for paths, curbs, paving, construction storage space and hardscape for plants, etc.  
  - Retain top soil, treat it on site with compost for other remediation and use for green roofs, soft landscape, etc.  
  - Manufacture for soil using surplus excavated soil blended with compost.  
  - Use bricks, concrete paving bricks and excavated rock for landscaping finishes, feature, etc.  
  - Use existing soft landscape that cannot be reused times, simplified as compost,  
  - Soft landscape topsoil,  
  - Tree roots, furniture, and  
  - Large features like tree stumps, etc.  
  - Reuse existing landscape elements including rather than throwing away (e.g., existing fencing, benches, etc.). |
| Concrete | Recycle aggregates either on site or off site for concrete mix, as fill, etc.  
  - Incorporate cement substitutes PFA or GGBS as appropriate.  
  - Recycle concrete elements as aggregates and use them as a thermal heat store (thermal mass) used as fabric energy storage to reduce the operational energy requirements. |
| Packaging | Reuse packaging by returning to supplier, manufacturer or using it for other purposes (e.g., landfill packaging pallets can be chipped and used for landscaping topsoil). |
| Foundations | Reuse existing foundations  
  - Extract and reuse existing foundation. |
### Design For Reuse, Recovery & Materials Selection

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| Timber               | - Reuse timber spruce floors.  
                       - Reuse good quality timber for flooring.  
                       - Reuse timber for cladding, framing and other landscaping uses.  
                       - Separate, urban, and ship all timber pruning from demolition and use either for composting, top mulch or take off site for energy generation.  
                       - Reuse timber to construct landscape features (e.g. street furniture). |
| Bricks, Stones,      | - Reuse bricks, blocks, for masonry, internal partitions and facing cladding.  
                       - Reuse slate for roofing and landscaping. |
| Roofing Tiles, and   |                                                                                                                                            |
| Blocks               |                                                                                                                                            |
| Good Demolition      | - Reuse demolished elements, columns, beams, portal frames, curtain walls either on site or off site.  
                       - Reuse water tanks or site for reusable space within the design brief.  
                       - Encourage the client to adopt a ‘soft rip’ demolition process.  
                       - All fixed fixtures and fittings to be saved and donated to charities for reuse, or sold for reuse.  
                       - Other floor finishes, carpet etc to be not used for reuse, donated to charity or sold for reuse.  
                       - Good quality doors set aside for reuse. |
| Contractor’s Site     | - Use existing buildings on site for contractor’s site establishment.  
                       - Use temporary site establishment buildings that can be reused. |
| Establishment        |                                                                                                                                            |

### Design For Off Site Construction

<table>
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| Modular Design        | - Design with modularisation in mind.  
                       - Modularise building (i.e. install certain walking systems, master panel) panelled.  
                       - Use door sets rather than doors.  
                       - Use modular solutions for:  
                       | homes, office, clinics, hotel, etc.  
                       | - use all fixtures and fittings.  
                       | - services, plant room etc.  
                       | - laboratory units, work stations etc.  
                       | - cladding.  
                       - Use timber panels as modular frame - used to construct up to new storey buildings. |
| Volumetric            | - Use prefabricated solutions for:  
                       | - lobby and bathroom fixtures, etc.  
                       | - changing rooms.  
                       | - hospital inpatient rooms with en-suite etc.  
                       | - modular kitchen, guest kitchens for office spaces.  
                       | - plant rooms.  
                       | - operating theatres. |
| Precast Concrete      | - Use precast concrete solutions for:  
                       | - stairs and stair walls.  
                       | - lighting shafts.  
                       | - stairwells.  
                       | - shafts.  
                       | - lift shafts. |
| Steel Construction    | - Use steel frame design.  
                       - Use prefabricated steel stairs.  
                       - Use steel for lift cores and core units.  
                       - Use high rise foundations to enable future reuse. |

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### Design For Materials Optimisation

<table>
<thead>
<tr>
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<tbody>
<tr>
<td>Concrete</td>
<td>Use pre-mined and reclaimed aggregates to reduce embodied carbon; Use recycled/reused/alternative shoring for design and construction of buildings; Use recycled/reused/alternative shuttering for design and construction of buildings.</td>
</tr>
<tr>
<td>Design</td>
<td>Select and plan choice and sustainability; Minimise material use and surface finish; Question and reduce if possible the use of permanent materials; Consider alternatives to materials (e.g. precast) for their assets properties.</td>
</tr>
<tr>
<td>Services</td>
<td>Rigorously plan WMS layout and distribution to ensure access requirements and facilitate future maintenance; Rigorously plan WMS layout and distribution, route to enable visual access by communicating, moving, dust, etc; Enable consolidation of trades to reduce material consumption at finished surfaces.</td>
</tr>
<tr>
<td>Detail design</td>
<td>Reduce the necessity for site finishes (e.g. skirting, lining) by adopting “as built” elements (e.g. minimal finish; Optimise substructure usage by re-using existing materials; Use floor slabs as a floor for use as of material.</td>
</tr>
<tr>
<td>Assistance of excavation</td>
<td>Use monolithic solutions rather than separate joint.</td>
</tr>
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### Design For Materials Optimisation

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<tbody>
<tr>
<td>Standardisation and dimensional co-ordination</td>
<td>Use 3D modelling to assist clashes/conflicts of services/structure etc. and thus reduce construction errors and consequent rework.</td>
</tr>
<tr>
<td></td>
<td>Co-ordinate structure and services so that both can be combined for off-site or near-site thus avoiding the need to cut down on site and other builders work.</td>
</tr>
<tr>
<td></td>
<td>Co-ordinate structural grid and planning grids etc. to avoid offsets.</td>
</tr>
<tr>
<td></td>
<td>Use 3D modelling to assess, all finishes layouts and systems to reduces on-site waste such as:</td>
</tr>
<tr>
<td></td>
<td>Sheet vs. Trim vs. Formwork materials.</td>
</tr>
<tr>
<td></td>
<td>Standardise finish and lamp.</td>
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<tr>
<td></td>
<td>Standardise windows, doors and glazing areas.</td>
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</tbody>
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## Design For Waste Efficient Procurement

<table>
<thead>
<tr>
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<tbody>
<tr>
<td>Supply Chain</td>
<td>Enforce waste operator’s compliance with waste minimization. Discuss methods of waste minimization with suppliers and manufacturers of wall fixing systems. Discuss methods of waste minimization with potential subcontractors and suppliers at an early stage. Discuss options for packaging reduction with subcontractors and suppliers. Discuss future flexibility with plasterboard manufacturers.</td>
</tr>
<tr>
<td>Specification</td>
<td>Simplify the contract specification to reduce number of plasterboard types. Specify responsibly sourced materials that reduce waste. Specify adequate protection to fragile materials to minimize damage on site.</td>
</tr>
<tr>
<td>Contract/Contractor</td>
<td>Involve the contractor from early design stages to identify methods of waste minimization in relation to procurement routes. Consider financial incentives and penalties to reduce waste. Involve the contractor from early design stages to identify methods of waste minimization in relation to procurement routes.</td>
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## Design For Waste Efficient Procurement

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<tr>
<td>Contract/Contractor</td>
<td>Consider financial incentives and penalties to reduce waste. Require the contractor to produce a SWMP at an early stage that includes a site storage and logistics plan. Require all tendering contractors to provide information on how they plan to reduce waste through the supply chain and site activities. Require Just In Time (JIT) delivery. Use consolidation centres to facilitate JIT delivery. Select procurement routes that minimise packaging. Use ordering procedures that avoid waste (e.g., no over ordering, take-back schemes for both material surplus and officials). Plan the work sequence to reduce on-site waste. Include within the tender documents the requirement to sign off ‘the waste per work package’ – waste must not exceed a contractual agreed limit.</td>
</tr>
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### Design For Deconstruction & Flexibility

<table>
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<tr>
<th>Opportunity</th>
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<tbody>
<tr>
<td>Logistics</td>
<td>Design deconstruction at an early stage. Discuss with supplier if components can be returned</td>
</tr>
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