Sustainable Construction Strategies: A Singapore Perspective

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Land Area: 710.2 km²
Population: 4.8 mil
Density: 6800 /km
Our Challenges

- Island city-state
- No natural resources
- Small & densely populated
Sustainable Development

- Resource Management
- Pollution Control
- Transport Management
- Greening/Biodiversity

Governance: Long Term Planning, Policies, Technology

Waste – Towards Zero Landfill
70% Recycling Rate in 2030
Understanding Sustainable Construction

- Adoption of environmentally friendly building designs, construction methods and materials
- Reduce use of natural resources
- Increase use of recycled materials
Reduction of 30% in Use of Natural Aggregates in Building Projects by 2020

Recycling and Use of Recycled Materials

Efficient Design to Optimize Use of Natural Materials
Increase use of recycled & eco-friendly building materials

Encourage efficient design & use of building materials

- Government Taking The Lead
- Promoting SC in Private Sectors
- Building Industry Capabilities via Collaborations
- Strategic Profiling & Raising Awareness
- Minimum Standards through Legislation
**Government Taking the Lead**

Sustainable Construction Steering Group (SCSG)

- **Government Taking The Lead**
- **Promoting SC in Private Sector**
- **Building Industry Capabilities**
- **Strategic Profiling & Raising Awareness**
- **Minimum Standards through Legislation**

**Government Agencies**

- Adopt demolition protocol for resource recovery
- Use of recycled concrete aggregates in non-structural building elements, and aircraft pavement construction
- Use of IBA for roads

**Tertiary Institutions**

**Industry Associations**

RMCAS
Promoting SC in Private Sector

Recognition under national Green Building Rating Scheme

Incorporated into BCA’s Green Mark

- Concrete usage index (CUI); and
- Adoption of recycled / alternative materials
Promoting SC in Private Sector

Green & Gracious Builders Award

Award to recognise the efforts of builders to adopt environmentally friendly and green practices in construction work

“Build it Green!”
Building Industry Capabilities via Collaborations

Capability Development

Exploring funding support to build up industry capabilities:
- Demolition Contractors
- C&D Waste Recyclers
- RMCs

Accreditation of Recyclers

Industry-led accreditation scheme to upgrade quality and recycling standards
Building Industry Capabilities via Collaborations

Pilot Projects
- Eco-structure demonstration project with private sector
- Recycled materials & green cement for structural use

Samwoh Eco-structure
Tampines Concourse
Goodwood Residences
Strategic Profiling & Awareness

Raising Public Awareness

• BCA Gallery:
  - Showcase materials and technologies for sustainable construction
  - Public outreach platform, especially to younger generation

Government Taking The Lead
Promoting SC in Private Sector
Building Industry Capabilities
Strategic Profiling & Raising Awareness
Minimum Standards through Legislation
Setting Min. Standards through Legislative Requirements

**Phase 1: Establish Standards for Recycling & Require Declaration of Waste Generation**

**Phase 2: Introduce Protocols to Encourage Greater Recovery and Recycling**

**Phase 3: Consider Legislation for Recycling of Demolition Waste**
## Potential Waste Materials for Alternative Aggregates

<table>
<thead>
<tr>
<th>Waste Generated in 2007</th>
<th>Quantity (T/yr)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Steel Slag</td>
<td>0.1 M</td>
</tr>
<tr>
<td>2. Milled Waste</td>
<td>0.5 M</td>
</tr>
<tr>
<td>3. Copper Slag</td>
<td>0.4 M</td>
</tr>
<tr>
<td>4. Demolition Waste</td>
<td>2.0 M</td>
</tr>
<tr>
<td>5. Incineration Ash</td>
<td>0.5 M</td>
</tr>
<tr>
<td>6. Dredged Material</td>
<td>0.5 2 M</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>4-5.5 M</strong></td>
</tr>
</tbody>
</table>
Waste to Resource: From Demolition to New Build

KEY APPROACHES: WASTE TO RESOURCE

INCREASING SUPPLY \[\Leftrightarrow\] \[\Rightarrow\] DRIVING DEMAND

WASTE DISPOSAL

TENDER \[\rightarrow\] DEMOLITION \[\rightarrow\] RECYCLING \[\rightarrow\] SUPPLIER / RMC \[\rightarrow\] CONTRACTOR \[\rightarrow\] NEW BUILD

DEVELOPER / CONSULTANT

AIM:
- Allow resource recovery
- Max recovery via Demolition Protocol
- Max quality via Quality Control
- Use of recyclate (%) (\(\%\))
- Max reuse in construction
- Specify recycling parameter

KPI:
- Demolition Recovery
- New Build Recycling Indicator
Key initiatives in increasing supply:

- Demolition Protocol
  (to maximize resource recovery)

- Quality Control
  (to provide quality consistency)

- Alternative Materials
  (to achieve resource efficiency)
Demolition Protocol

Guidance on how demolition wastes should be treated as a resource in new build:

**Pre-Demolition Audit**
- Framework for identifying potential resources available
- Identifying appropriate steps for demolition and targets for recovery / recycling

**Sequential Demolition**
- To optimize the resource recovery

**Waste Segregation**
- To obtain max resource quality for processing
Quality Control

- Accreditation Scheme for Recycled Aggregates
  - Class 1: RCA meeting SS EN 12620
  - Class 2: General usage

- Classification System:
  - Recycled Aggregates with % masonry content
    - Crushed concrete from structural components
    - Crushed concrete / crushed brick / crushed tiles
    - Crushed concrete / other constituents

- Assurance in quality consistency of end products
- Source of reliable suppliers for all
- Greater product acceptance & marketability
Alternative Materials

- Recycled Concrete Aggregates (RCA)
  - *For struc use:* max 20% replacement of coarse agg
  - *For non-struc use:* at least 50% replacement

- Washed Copper Slag
  - *For struc use:* max 10% replacement of fine agg
  - *For non-struc use:* at least 50% replacement

- Steel Slag
  - *For roads surfacing aggregates: wearing course*

- Green Cements
  - *OPC replacement using GGBS, fly ash, silica fume*

- Others: IBA, Dredged Material
Key initiatives in driving demand:

- **Linkage** (between demolition and new build phases)
- Policy instruments on use of recycled materials
- Guidance, best practices and case studies
Linkage (Demolition <-> New Build)

A mechanism to relate demolition and new build:

- Demolition and New Build
  - Demolition Protocol and Recyclate Utilization Plan
- New Build only
  - Specification on min % use of Recycled Materials
Instruments – “driving demand”

Key instruments that influence design:

• Regulatory Mechanism: *Green Mark Scheme*
• Code and Standards: *SS EN 12620, BS 8500-2, CP 11*
• Promotion and Education
  • Guidebooks on best practices
  • Demo and pilot projects
  • Training courses, workshops
  • Seminars, exhibitions
  • Incentive scheme to build up capabilities
3-Storey Commercial Building using RCA

- Live case study to evaluate the use of Recycled Concrete Aggregates (RCA) in structural concrete for buildings

Synthetic Aggregates from Dredged Materials

- Convert dredged materials and industrial wastes into synthetic sand and aggregates using crystallization technology

Sustainable and Cost Effective Wall

- Production of hollow core wall panels using recycled materials and extrusion technology

Specification and Classification of RCA

- Evaluate the effect of the quality of RCA on properties and performance of concrete
Key Initiatives

**KEY APPROACHES: WASTE TO RESOURCE**

- Increasing Supply
- Driving Demand

**Waste Disposal**
- Tender
- Demolition
- Recycling

**Developer/Consultant**
- Supplier/RMC
- Contractor
- New Build

**KEY INITIATIVES**

- Demolition Protocol
- Classification System
- New Materials or Methods
- Recyclate Utilization Plan
- Guidance Publication
- Incentives

- Specification and Classification of RCA
- Synthetic Aggregates from Dredged Materials
- 3-Storey Commercial Building using RCA
- Sustainable and Cost Effective Wall

**DEMO PROJECTS**
Thank You

- green
- environmental friendly
- reduce reuse recycle
- sustainable built environment

WE DID IT WITH GREEN CONCRETE!