

# GREEN and GRACIOUS

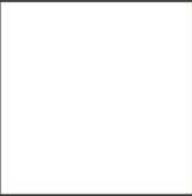
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## Builder Guide



Building and Construction Authority

We shape a **safe**, **high quality**, **sustainable** and **friendly** built environment.

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## FOREWORD

BCA launched the Green and Gracious Builder Scheme in February 2009. The scheme was introduced to raise the environmental consciousness and professionalism of builders. It is also a benchmark of a builder's corporate social responsibility to the environment and the general public. Apart from setting standards for green practices, it also sets standards for gracious practices. These gracious practices will improve the image of our builders and the construction industry particularly among neighbours and residents, some of whom may have been affected by construction activities near them.

To complement the scheme, BCA has produced this Green and Gracious Builder Guide to share with the industry, best practices of builders in addressing environmental concerns and mitigating possible inconveniences to the public caused by construction works. These best practices were compiled from on-site observations of various builders certified under the Green and Gracious Builder Scheme.

The guidebook highlights the green technologies and methods that builders used to reduce/reuse/recycle, save energy and reduce water consumption on construction sites. It also illustrates some of the gracious best practices that builders have adopted to enhance accessibility, public safety, reduce noise and vibration, and improve communication and workforce management on site.

Green and gracious construction practices are vital in our objective to achieve in a gracious manner, a truly sustainable built environment in Singapore. This guide should come in handy to those who are unsure how to do it but want to make a start. There is nothing better than learning from those that have embarked on and excelled in the same journey.



**Tan Tian Chong**  
Director  
Technology Development Division  
Building and Construction Authority

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# 1 INTRODUCTION

BCA's efforts at developing a sustainable built environment have gained sufficient momentum and been well accepted by the industry. Many have responded enthusiastically to the BCA Green Mark Scheme – a scheme that recognises the efforts of developers, architects and engineers in contributing to environmental sustainability in their development projects. However, one of the key players in the construction value chain, the builders, has not been well recognised. They also do contribute to environmental sustainability and environmental protection when they go green and adopt 'friendlier' construction site management and practices. Given the high visibility and impact of construction works, it is also important for builders to be socially responsible to the environment, the neighbours and general public by gracious practices during construction. Hence the Green and Gracious Builder Scheme was introduced to raise the environmental consciousness and professionalism of builders. Together with the BCA Green Mark Scheme, this scheme will form part of the holistic framework to shape a sustainable built environment for Singapore.

This guidebook sets out the best green and gracious practices to assist builders in addressing environmental concerns and mitigating possible inconveniences to the public caused by construction works. The green and environmentally friendly best practices encourage the use of recycled materials and reduction in energy and water consumption on site. The gracious best practices encourage builders to address the public needs and concerns, such as enhanced communications, consideration for public accessibility, mitigating noise and vibrations, minimizing, if not eradicating disturbance in the vicinity and neighbourhood. Several innovative green solutions or technologies that address energy efficiency in the site office, green and conducive site environment and innovative gracious practices are also highlighted.

All the practical examples in this Guidebook have been gathered from the builders which participated in the Green and Gracious Builder Scheme. It is useful guide for builders who wish to benchmark their projects for environmental sustainability and corporate social responsibility to the environment and the general public.

Details of the Green & Gracious Builder Criteria are shown in the Appendix.

## 2 GREEN PRACTICES

### 2.1 Company Policy

- 2.1.1 The builder should have a policy and implemented measures to raise awareness, educate and inculcate green best practices across all levels of staff. Some of these practices can include briefing sessions, sharing sessions, in-house quiz and green campaigns.



Photo 2.1a

A builder sets up a Green & Gracious Code to inculcate green best practices across all levels of staff.

## **SECTION 1**

### **GREEN Policy Statement**

*Lum Chang Building Contractors Pte Ltd* shall be responsible for protecting the Environment through acceptable Green practices that produces a reduction of Carbon Gas into the air, minimizing the Carbon Footprint through Recycling, Reuse and Reduction arising from the following:

- (1) Comply to the local Environmental & Governmental Legislation;
- (2) Train and Promote Awareness on Environmental Aspects related to works for all Personnel;
- (3) Use natural resources, especially energy and water, efficiently;
- (4) Reduce waste i.e. gaseous, liquid or solid generation so as to minimize its pollution on air, water, land and the other aspects of the Environment;
- (5) Prepare for and endeavor to prevent any Emergencies that affect the Environment;
- (6) Improve continuously the Environmental Performance and Practices in the Company;
- (7) Prepare Environmental Objectives and Targets, where applicable, and ensure they are reviewed at specified intervals;
- (8) Communicate and make available our Environmental Policy and Performance to Staff and all interested Parties inclusive of Clients, Neighbors, Suppliers, Subcontractors and the Public.
- (9) Selection of Sub-Contractors and Suppliers who are Environmental Partners.
- (10) Mechanize the construction process to reduce the use of timber and fossil fuels

20 APR 2009

TAN WEY PIN  
EXECUTIVE DIRECTOR

### **Photo 2.1b**

Another builder demonstrates the top management's commitment through a Green Policy statement.



### **Photo 2.1c**

Briefing session on the company's green policy conducted for the management staff.



**Photo 2.1d**

Workers received recyclable goodie bags and trained on the concept of recycling at the same time.



**Photo 2.1e**

The training for workers tends to be more hands on and visual. This could be done through tools like the recycling bins and posters.

- 2.1.2 In addition to educating their management staff and workers, the builder is also recognised for their effort in selecting suppliers and subcontractors that are conscious about green issues. This can be achieved through setting specific green criteria during the pre-qualification or evaluation of the suppliers and subcontractors.

## 2 GREEN PRACTICES

### 2.2 Reduce/Reuse/Recycle

- 2.2.1 Measures to reduce, reuse and recycle construction and office waste are an integral part of a builder's green practices. The builder should separate, recycle and reduce construction waste such as timber, plastic packaging and other related waste. While the main focus is on construction waste, the builder should also go the extra mile to recycle office waste.



**Photo 2.2a**

The segregation of waste into construction, organic, or timber waste, metal cans, papers or plastic is the first step in Reduce/Reuse/Recycle.



**Photo 2.2b**

Regular campaigns and training will help to cultivate recycling mindset in workers.



**Photo 2.2c**

The management and project staff can also play their part by recycling paper in the site office.



**Photo 2.2d**

Milled waste is recycled to cover access road on site. This practice greatly reduces environmental dust pollution generated on site.



**Photo 2.2e**

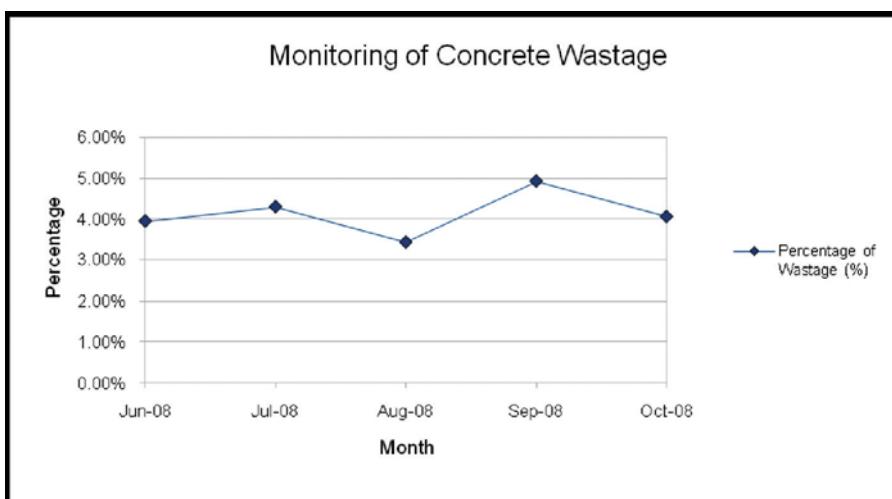
Instead of throwing unwanted electrical wire hooks away, a builder can recycle them as rebar protectors on site.

- 2.2.2 It is important that the builder keeps track of waste management on the site. This can be monitored through key indicators like concrete wastage, rebar wastages and waste disposal cost. Through this monitoring, the project team can initiate measures to tackle and reduce wastage.



**Photo 2.2f**

Example of using monthly monitoring chart to track metal waste on site.



**Photo 2.2g**

Example of monitoring concrete waste on site.

2.2.3 Use of technologically advanced formwork and platform systems can help to reduce the use of timber formwork on site. These formwork and platform systems are highly recyclable, more durable and require less manpower to install and dismantle than conventional timber form. In some cases, they also mitigate other issues such as noise and dust generation.



**Photo 2.2h**

The Integrated Modular Formwork is highly recyclable and requires less manpower to install and dismantle.



**Photo 2.2i**

The jump form and table form replaced the use of timber form, thus resulting in lesser timber usage.



**Photo 2.2j**

The climbing cage system results in reduction in the use of scaffolding.



**Photo 2.2k**

Usage of drywalls will reduce masonry works on site.

- 2.2.4 In line with sustainable construction efforts, the builder is recognised for using recycled and sustainable materials for non structural applications.



**Photo 2.2l**

Precast drains using recycled aggregates is popular among builders.



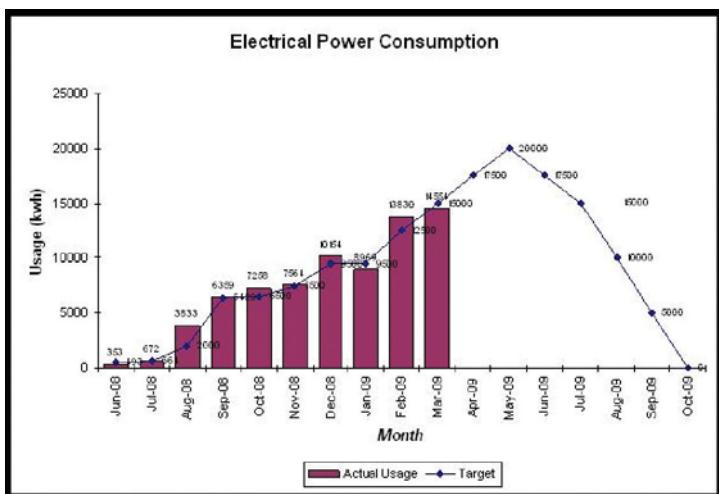
**Photo 2.2m**

Precast road kerbs and wheel stoppers are examples of non structural elements that can use recycled materials.

## 2 GREEN PRACTICES

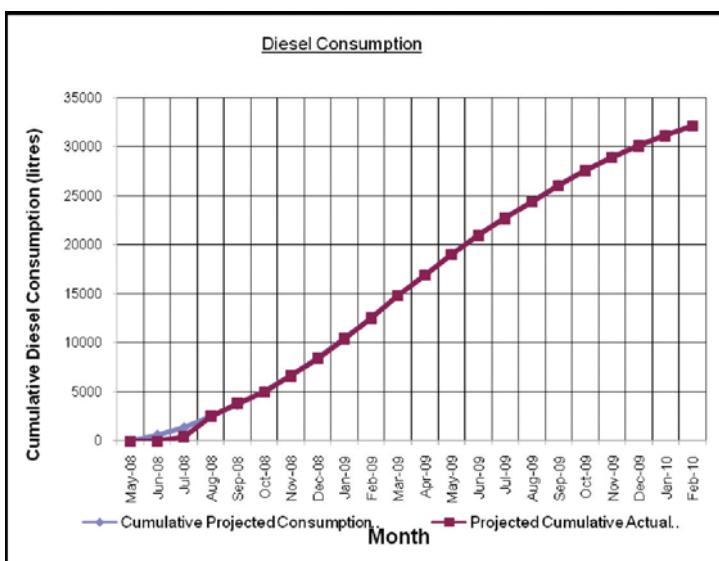
### 2.3 Energy

- 2.3.1 The builder should track energy consumption on the site. This can be done through monitoring key indicators like the electricity and diesel consumption. This will enable the builder to set strategies to reduce energy consumption and increase cost saving.



**Photo 2.3a**

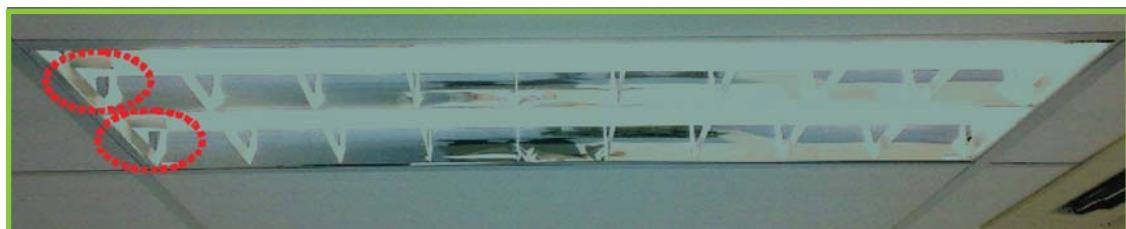
An example of a monthly monitoring chart to track electrical power consumption on site.



**Photo 2.3b**

Another example of monitoring diesel consumption.

2.3.2 The builder is recognised for their effort in reducing energy usage in the site office. This can be achieved through the use of energy saving equipment like energy efficient lightings, energy efficient air conditioning systems and Green Label appliances.



**Photo 2.3c**

The combination of T5 lighting and motion sensors greatly reduce energy consumption in the site office.



**Photo 2.3d**

Energy efficient air conditioning systems that comply with the Singapore Energy Labeling Scheme help to save energy in site office.



**Photo 2.3e**

Energy efficient refrigerator that complies with Singapore Green Labeling Scheme helps to save energy in site office.

2.3.3 Alternative renewable energy or fuel for construction machinery and equipment should be used. Solar cells and biodiesel can be used instead of non renewable diesel fuels.



**Photo 2.3f**

Use of solar panels to help power the site office.



**Photo 2.3g**

Use of solar panel to power the noise meter.



**Photo 2.3h**

Experimental use of solar cells to help power the water treatment plant.



**Photo 2.3i**

Biodiesel, a combination of bio-fuel and diesel, helps to reduce the usage of diesel and also causes less air pollution.

- 2.3.4 Diesel powered generators are not as efficient as AC Grid power supply and can cause air and noise pollution. The builder should connect to AC Grid power supply whenever feasible and alternate usage to optimize energy use.



**Photo 2.3j**

Energy usage can be optimised through good management of alternating use of AC Grid power supply and diesel powered generators.

## 2 GREEN PRACTICES

### 2.4 Environmental/Water

- 2.4.1 Water consumption and Total Suspended Solids (TSS) readings on site should be tracked. Monitoring these key performance indicators will enable the builder to develop plans to reduce water consumption and keep the waterways clean.

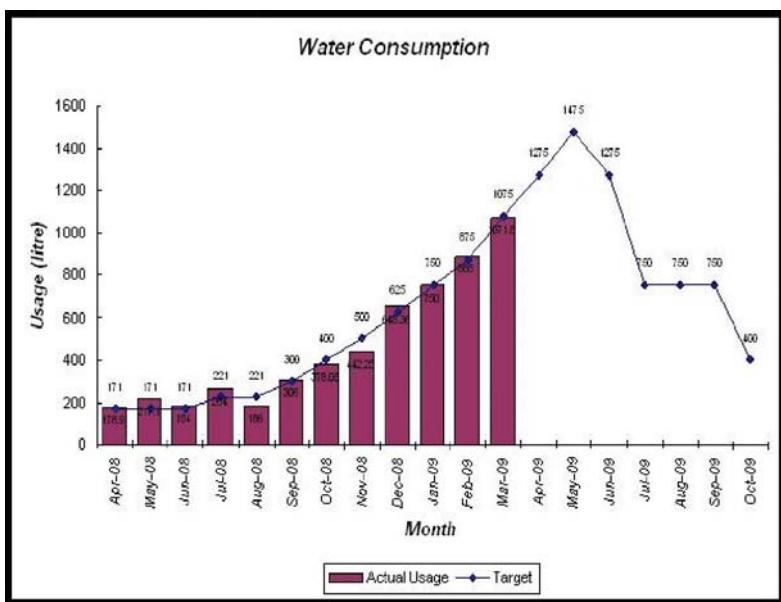


Photo 2.4a

An example of using a monthly monitoring chart to track water consumption on site.



Photo 2.4b

Simple tools/equipment to monitor TSS readings.

2.4.2 Efforts in using water saving or recycling equipment to conserve water usage are recognised. This can be achieved through water recycling plants to treat and recycle water for non-potable and construction use.



**Photo 2.4c**

Water treatment & recycling plant that utilise membrane technology.



**Photo 2.4d**

Another common water treatment & recycling plant that utilise chemical technology.



**Photo 2.4e**

Recycled water is commonly used for flushing of toilets on site.



**Photo 2.4f**

Recycled water used for washing of vehicles at washing bay and watering plants.



**Photo 2.4g**

Recycled water used for grouting, waterproofing and tiling works.

2.4.3 Environmental friendly products like non toxic pesticides and cleaning products should be used.



**Photo 2.4h**

Use of non toxic pesticides helps to reduce adverse impact on the environment.



**Photo 2.4i**

Use environmentally friendly cleaning products to lessen impact on environment.

## 2 GREEN PRACTICES

### 2.5 Housekeeping & Air Quality

- 2.5.1 Good housekeeping procedures and a well maintained site not only produce a pleasant working environment but it also enhances site productivity and safety. One possible measure is to implement a management procedure that encourages subcontractors to adopt good housekeeping practices. Another measure can be designating proper storage space to ensure materials are properly stored on site.



**Photo 2.5a**

A good housekeeping program will ensure all subcontractors adopt good housekeeping practices.



**Photo 2.5b**

Designated storage spaces allow materials to be properly stored on site.

2.5.2 Measures that mitigate generation of dust are recognised. This can be done through various simple measures.



**Photo 2.5c**

Covering stock piles with sheets help to mitigate dust generation on site.



**Photo 2.5d**

Spraying water on site access roads and during hacking works will reduce dust generation. This is especially effective during dry days.



**Photo 2.5e**

Spray water to dampen dust generating materials and cover them properly during transportation.



**Photo 2.5f**

Pavement sweeper is a useful equipment to clean up public roads or surrounding areas.

2.5.3 Providing regular maintenance of machinery and equipment will greatly reduce emissions from machinery and equipment and thus control air pollution.



**Photo 2.5g**

Regular maintenance of machinery reduces air pollution.

2.5.4 The human factor plays a crucial role in ensuring proper housekeeping and cleanliness on the site. This can be achieved by designating site personnel or controller to oversee, implement and inspect housekeeping on site.



**Photo 2.5h**

Designated personnel are important in ensuring proper housekeeping and cleanliness on site.

### 3 GRACIOUS PRACTICES

#### 3.1 Company Policy

- 3.1.1 The builder should set up a policy advocating gracious best practices in construction. Procedures should be instituted to raise awareness, educate and inculcate gracious best practices across all levels of staff. The practices can include briefing and sharing sessions, in-house quiz and gracious campaigns.



**Photo 3.1a**

An example of a green and gracious company policy by a certified green and gracious builder.



**Photo 3.1b**

Briefing session on company's policy on best practices in construction, conducted for management and staff.

- 3.1.2 In addition, the builder should set up a system for gathering feedback from staff, suppliers and subcontractors on gracious practices.



**Photo 3.1c**

Train suppliers, subcontractors and workers and gather feedback from them on gracious practices.

### **3 GRACIOUS PRACTICES**

#### **3.2 Accessibility**

- 3.2.1 The entrance and access to a construction site is particularly important as they are clearly visible to the public. The builder should maintain the site entrance properly and ensure it is unobstructed. Access to site office should be properly documented to facilitate entry by staff, workers and visitors.



**Photo 3.2a**

A clean and unobstructed site entrance portrays a positive image of the builder to the public.



**Photo 3.2b**

Proper signages provide guide to visitors.

3.2.2 It is also good practice to provide barrier free access at passageways used by the public.



**Photo 3.2c (Left)**

A temporary ramp helps pedestrians at a walkway affected by construction works.

**Photo 3.2d (Right)**

A temporary ramp besides site hoardings is also useful to public users.



**Photo 3.2e**

A ramp has also been built near the site office.

3.2.3 The builder should implement measures to address possible causes of traffic obstruction. This can be effected by deploying traffic controllers to ensure smooth traffic flow in and out of the site. They also play an important role in guiding traffic during concreting operations or material delivery to minimise inconvenience to other road users.



**Photo 3.2f**

The traffic controller guides traffic during concreting operations or materials delivery.

- 3.2.4 Signages should be put up to guide motorists and pedestrians whenever there are road or traffic diversions. The builder should also ensure that existing directional signs are not blocked by hoardings or construction works.



**Photo 3.2g**

Some examples of good signages around the construction site.

### **3 GRACIOUS PRACTICES**

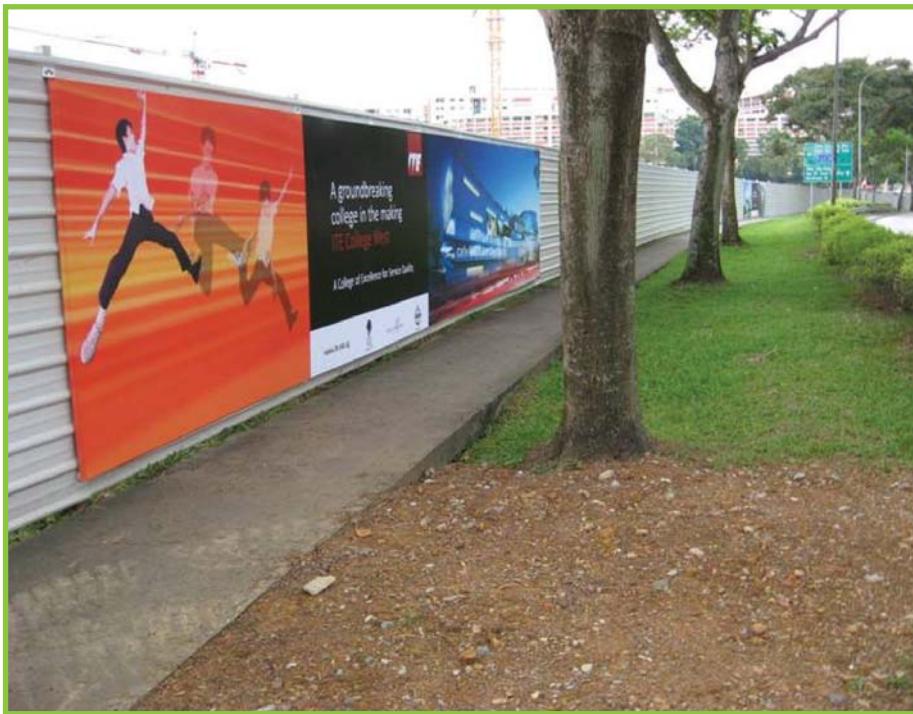
#### **3.3 Public Safety**

- 3.3.1 Covered walkways should be provided for areas that are heavily used by the public. This provides the public with a safer environment adjacent to the site and acts as a shelter during bad weather. In addition, the hoardings around the site should be well maintained and clean. It is worth noting that hoardings that are aesthetically pleasing tend to be more pleasant and acceptable to the public.



**Photo 3.3a**

Covered walkways around the perimeter as well as within the site provides protection and shelter.



**Photo 3.3b**

Well designed hoardings are aesthetically pleasing to the environment.



**Photo 3.3c**

Hoardings are maintained in good and clean condition through regular maintenance.



**Photo 3.3d**

Hoardings with vertical greens can look pleasing to the public.

3.3.2 Providing full height safety netting and catch platform can mitigate risk of falling debris.



**Photo 3.3e**

The catch platform and safety netting work hand in hand to mitigate risk of falling debris.

- 3.3.3 Passageways around the construction site should be sufficiently wide to handle the volume of human traffic. Alternate routes should be provided when existing passageways are obstructed due to construction works.



**Photo 3.3f**

Some examples of passageways provided around construction site.

- 3.3.4 Site safety information should also be made available and clear to visitors. This information should include fire or emergency response plans.



**Photo 3.3g**

Safety information and emergency evacuation routes are essential items to display to both staff and visitors on the site.

- 3.3.5 It is also important that the builder carries out comprehensive assessment and monitoring of surrounding buildings to prevent settlement, movement and damage to surrounding buildings.



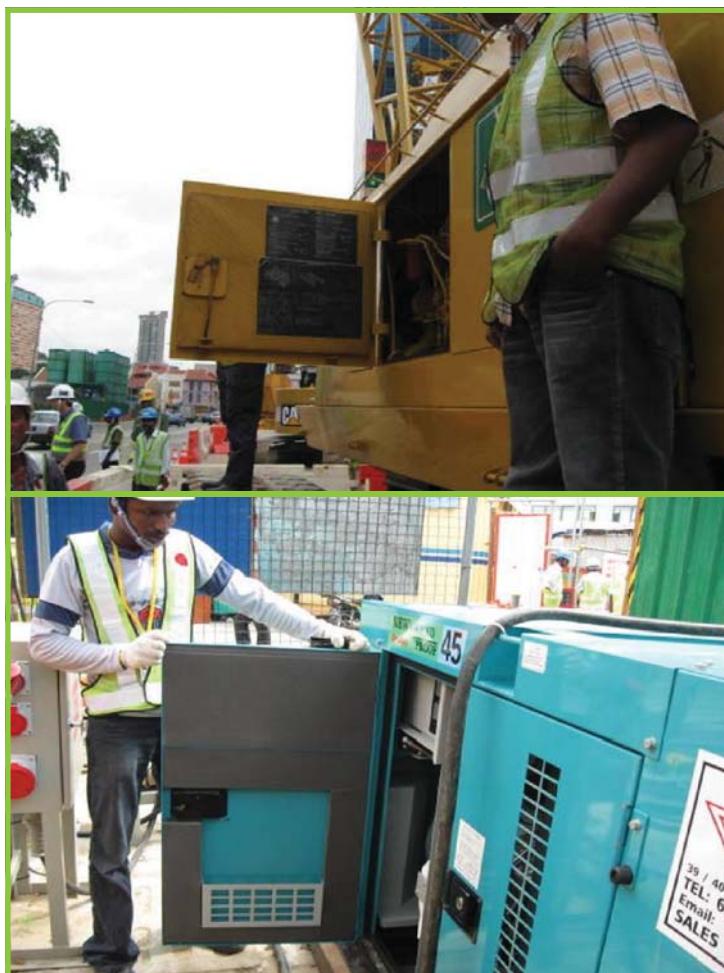
**Photo 3.3h**

Comprehensive monitoring of surrounding buildings can be done through the use of inclinometers, tilt meters, vibration meters and settlement markers.

### 3 GRACIOUS PRACTICES

#### 3.4 Noise & Vibration

- 3.4.1 Noise and vibration can be minimised or mitigated through careful scheduling of noisy activities and locating noise source away from residents. Other effective measures include containing noise at source and putting up noise barriers at noisy work areas.



**Photo 3.4a**

Use of sound proof materials for machinery can help to contain noise at source.



**Photo 3.4b**

Noise barrier panels around generators and machinery help to reduce the noise transmitted.



**Photo 3.4c**

Use of movable noise barriers can also reduce the noise transmitted from machinery.



**Photo 3.4d**

High noise barriers can help reduce noise transmitted from the construction site.

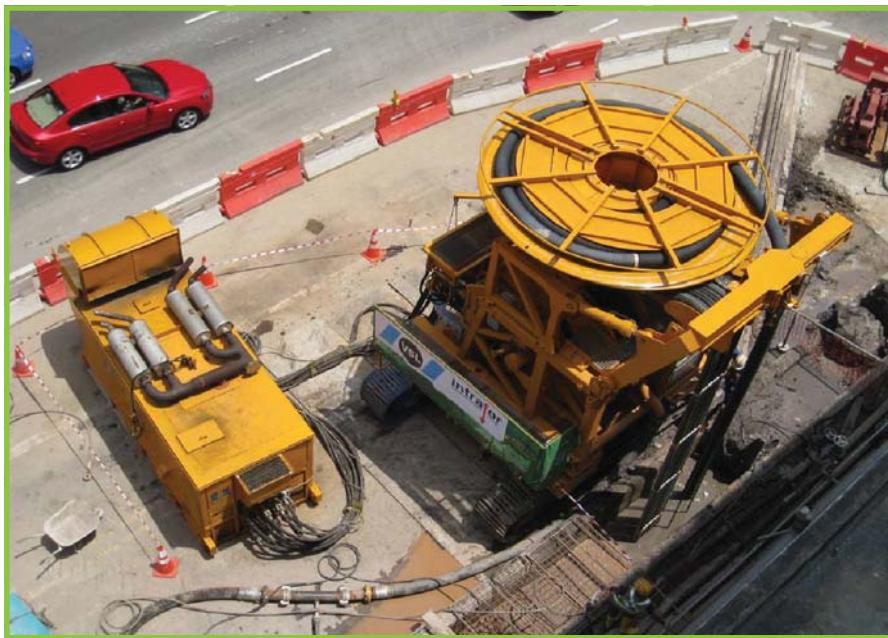
- 3.4.2 Regular maintenance of machinery and training of workers to properly handle machinery play an equally important role in mitigating noise and vibration.



**Photo 3.4e**

Machinery is regularly maintained and workers are properly trained to handle them.

- 3.4.3 Alternative construction methods that reduce noise and vibration should also be considered. This includes use of non percussion piling methods, low noise generators, robotic crushers, etc.



**Photo 3.4f**

State of the art technology cutter machine transmits little noise during operation.



**Photo 3.4g**

Silent jack in piles greatly reduce noise and vibration produced.



**Photo 3.4h**

Correct choice of piling system will mitigate noise and vibration felt by surrounding residents.

3.4.4 Installing noise and vibration monitoring meters can also help to ensure corrective action can be taken once the threshold limits are exceeded.



**Photo 3.4i**

Noise and vibration meters are installed for monitoring purpose.

### 3 GRACIOUS PRACTICES

#### 3.5 Communications

- 3.5.1 The builder should set up a policy that ensures pro-active communication to the various segments of the community around the site. This can be done by sending letters to neighbouring residents informing them about key milestones of the project or even visiting them personally.



**Photo 3.5a**

Distributing newsletters to neighbouring residents to update them on progress of project creates better understanding.



**Photo 3.5b**

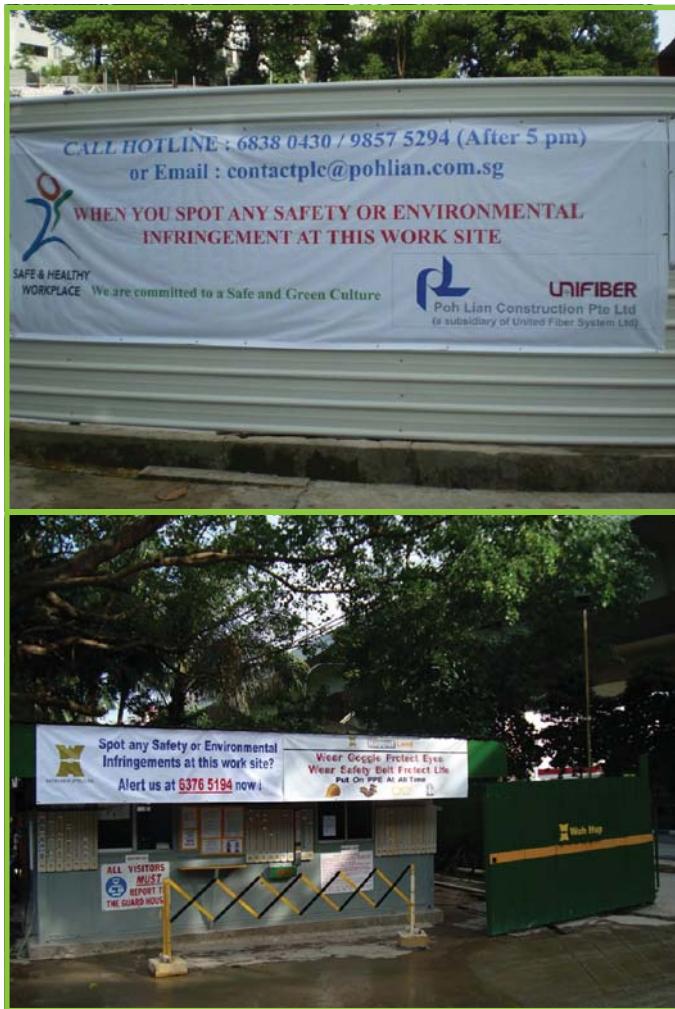
Pro-active visits to neighbouring residents with gifts during festive seasons help foster better rapport with residents.



**Photo 3.5c**

Where construction works affect business tenants, it is important that the builder hold regular meetings with the tenants to communicate the project's progress and gather feedback.

- 3.5.2 Putting banners or posters containing the builder's hotline number can open up and facilitate communication between members of the public and builder.



**Photo 3.5d**

Banners with hotline number(s) at prominent locations allow public to contact the builder to give feedback.

- 3.5.3 The builder should develop a set of guidelines to handle feedback and keep proper records of feedback. A designated site personnel should be appointed to manage the feedback and ensure all valid feedback are attended to expeditiously.

*Public Complaint Form*

Date: \_\_\_\_\_

**Information About You (Optional)**

Name: \_\_\_\_\_  
Address: \_\_\_\_\_ S( \_\_\_\_\_ )  
Phone : (H) \_\_\_\_\_ (O) \_\_\_\_\_ (H/P) \_\_\_\_\_  
Email : \_\_\_\_\_

I  
Complaint Issue: -

Noise	Dust	Traffic	Earth control	Others
-------	------	---------	---------------	--------

Date / Time / Location: - \_\_\_\_\_

Elaboration: -  
\_\_\_\_\_  
\_\_\_\_\_

**For Office Use Only**

Name of Person In-Charge: \_\_\_\_\_ Dept: \_\_\_\_\_  
Signature: \_\_\_\_\_ Date: \_\_\_\_\_ / \_\_\_\_\_ / \_\_\_\_\_ Time: \_\_\_\_\_ am / pm

Nature of Action Taken: - \_\_\_\_\_ Date: \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_



**Photo 3.5e**

Tools like “public complaint forms” or “suggestion box” placed at strategic locations can help to facilitate feedback from the public.



**Photo 3.5f**

A designated site personnel should be appointed to handle feedback from the public.

3.5.4 The builder is also recognised for their effort to implement measures to enhance security on site and in the site's neighbourhood.



**Photo 3.5g**

Builder's workers participate in "Workers on Watch" program administered by Singapore Police Force. Under the program, the workers play their part to help watch over security of the neighbourhood around the site.



**Photo 3.5h**

CCTV can be used by the builder to enhance the security on site and minimise security concerns of neighbouring residents.

### 3 GRACIOUS PRACTICES

#### 3.6 Workforce Management

- 3.6.1 The builder should educate their site staff and subcontractors' staff on best green and gracious practices.



**Photo 3.6a**

Briefing on best green and gracious practices conducted for site staff and subcontractors' staff.



**Photo 3.6b**

Training for workers can be more hands on and involves demonstration and practices.

3.6.2 The builder can show consideration to its workforce by providing welfare facilities to their workers. This can be done through provision of rest areas and recreational facilities.



**Photo 3.6c**

Care for workers through provision of rest areas and clean toilets.



**Photo 3.6d**

Provision of first aid facilities and first aider on site should be part of the welfare program of the builder.



**Photo 3.6e**

Participation of workers in morning exercises and other recreational activities add to their overall well being.



**Photo 3.6f**

Proper recognition and reward for workers will motivate them in a big way.

- 3.6.3 To complement the above measures, the builder may also need to implement disciplinary procedures to manage their workers.



**Photo 3.6g**

Training workers on dos and don'ts, good and bad practices help the builder to manage their workers.

3.6.4 Enhancing housing and living conditions for workers on site will also improve workers welfare on site.



**Photo 3.6h**

Some examples of improving workers' welfare at housing quarters include provision of hot water supply, vending machines and recreational facilities.

## 4 INNOVATION

### 4.1 Energy-Efficient Site Office

- 4.1.1 The builder should set strategies to reduce energy consumption on site and thus increase cost savings. Setting up an energy-efficient site office and the ability to reduce energy usage in the site office forms an important part of the overall plan.



**Photo 4.1a**

The site office is oriented in the north-south direction with the longer side, where there are more windows, facing north-south. This will reduce the heat intake into the site office and thus reduce energy consumption.



**Photo 4.1b**

The roof of the site office is painted with a heat shielding coating to reduce heat intake. The same can be done to the site office facades.



**Photo 4.1c**

Solar panels can be used to power part of the site office and thus reduce the electricity bill.



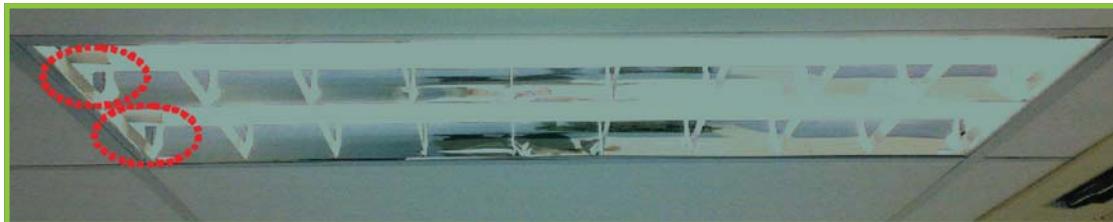
**Photo 4.1d**

The bigger capacity generators can be used in the day when the energy consumption is higher while the smaller capacity generator can be used at night when energy consumption is lower. This will optimise the usage of diesel and results in cost savings.



**Photo 4.1e**

Use of blinds and application of UV films on windows will help to reduce the heat transmitted into the site office. Thus less energy is needed to cool the site office.



**Photo 4.1f**

Combining use of energy-efficient T5 lightings and motion sensors can greatly reduce energy consumption in the site office.



**Photo 4.1g**

Use of energy-efficient air conditioning systems that comply with the Singapore Energy Labeling Scheme contributes substantially to a lower electricity bill.

## 4 INNOVATION

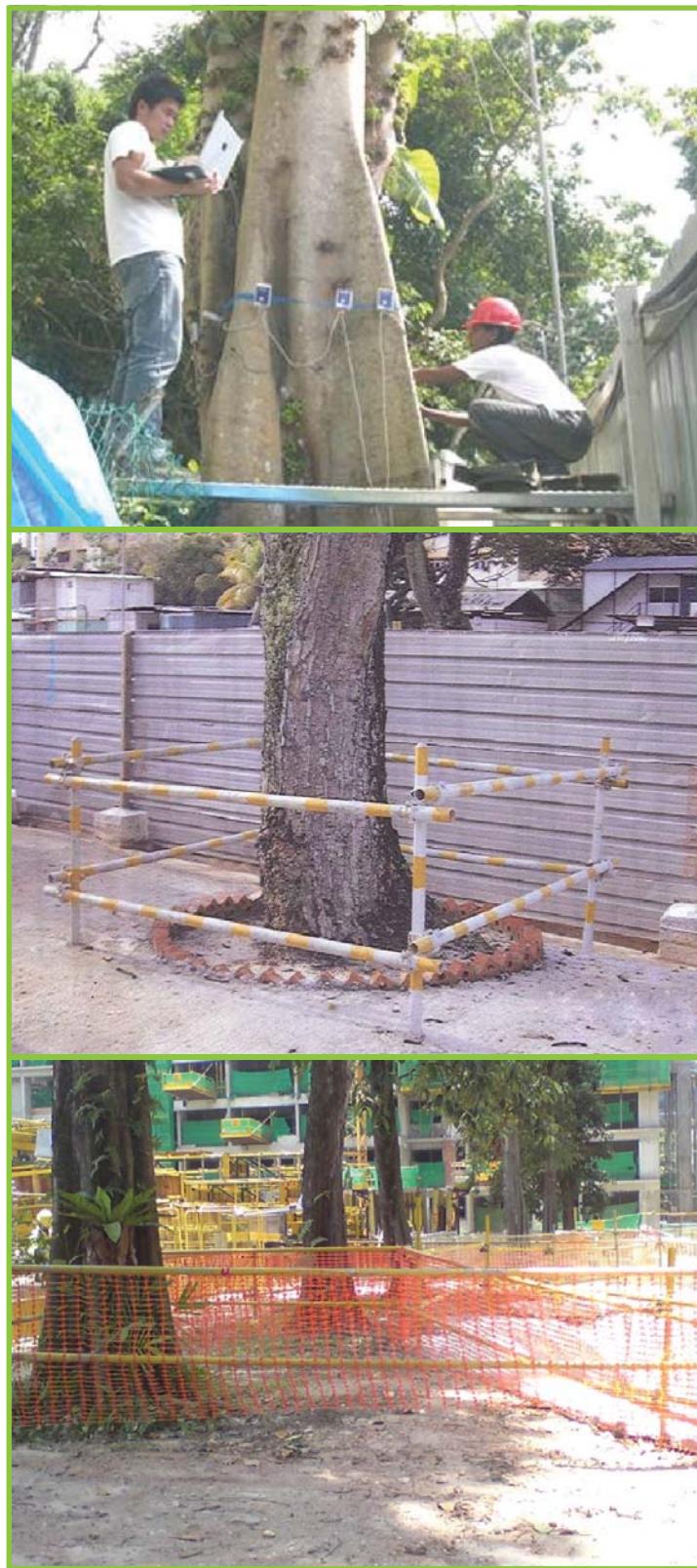
### 4.2 Green and Conducive Site Environment

- 4.2.1 The builder should build a green and conducive working environment on the construction site for its staff, subcontractors and workers. This will be a clear demonstration of the environmental friendliness and graciousness of the builder to the staff and workers on site.



**Photo 4.2a**

The greening of hoardings not only builds a conducive working environment for staff and workers, it also portrays a positive image to the public.



**Photo 4.2b**

The conservation of trees on site helps preserve the environment and provides shade and greenery for site staff. Specialists may need to be employed to monitor and recommend ways to preserve the health of the trees.



**Photo 4.2c**

Where space is available, plants and flowers can be planted to beautify the site environment. These plants can also double up as erosion control measures to enhance the quality of water discharged out of the site.



**Photo 4.2d**

A small roof garden above site office helps to cool the office.



**Photo 4.2e**

A netting and false ceiling for canteen area ensure staff and workers can rest and eat in a cooler and dust free environment.

## 4 INNOVATION

### 4.3 Other Innovative Gracious Practices

- 4.3.1 In addition to the gracious practices mentioned in the earlier chapters, some builders have implemented innovative practices related to accessibility, noise and vibration control.



**Photo 4.3a**

Variable message sign (VMS) system complements role of traffic controller and usage of signages. This tool helps to minimise inconvenience to the public.



### Photo 4.3b

Movable noise barrier can be used extensively at various locations where construction works are on going. It is an effective and easy way to reduce noise transmission to the public. There is also cost saving as no permanent noise barrier needs to be installed.

## **4 INNOVATION**

### **4.4 Demolition Protocol**

4.4.1 The demolition protocol helps contractors to better plan their procedures to maximise recovery of concrete waste for beneficial reuse/recycling. In most cases, a building structure is taken down in the fastest, most economical and convenient way, resulting in difficulty in sorting the various demolition wastes later. Having a demolition protocol facilitates segregation of concrete from other building materials, minimises contamination and significantly improves the quality of recovered concrete waste. It comprises 3 components: pre-demolition audit, sequential demolition and site waste management.

#### **4.4.2 Pre-Demolition Audit, Sequential Demolition and Site Waste Management Plan**

##### **1. Pre-Demolition Audit**

The Pre-Demolition Audit enables materials capable of being recovered for recycling to be identified e.g. concrete, bricks, metals, wood/timber, etc. This helps to identify potential resources and the level of material segregation required. The audit covers:

- Types of waste generated on-site
- Quantity of waste
- Recovery/Recycling Target

<b>Types of wastes</b>	<b>(A) Estimated Quantity (tons)</b>	<b>(B) Recovery Rate (%)</b>	<b>Target Quantity Recovered [A x B] (tons)</b>	<b>(C) Actual Quantity Recovered (tons/ truckloads)</b>	<b>(D ) Proposed Usage/ Course of Action</b>
<b>Concrete Components</b>					
Beams					
Columns					
Ground Slabs					
Pile Caps					
Walls					
Floor Slabs					
Others, please specify (e.g. roof slabs)					
<b>Masonry Components</b>					
Bricks					
Tiles					
Others, please specify (e.g. drywall)					
<b>Metals</b>					
Struc Steel					
Re-bar					
Others, please specify (e.g. frames)					
<b>Timbers</b>					
Doors					
Parquet					
Others, please specify					
<b>Plastics (e.g. PVC, sockets, pipes, etc)</b>					
<b>Miscellaneous</b>					

## **2. Sequential Demolition**

The demolition process is separated into phases in which one type of material is carefully dismantled at one time and salvaged for reuse and recycling. The wastes generated are of similar types and contamination by non-recyclable items can be significantly reduced. The sequence of demolition is principally carried out in reverse order to the construction process. The plan should allow separation and sorting of building materials.

The principal phases involve:

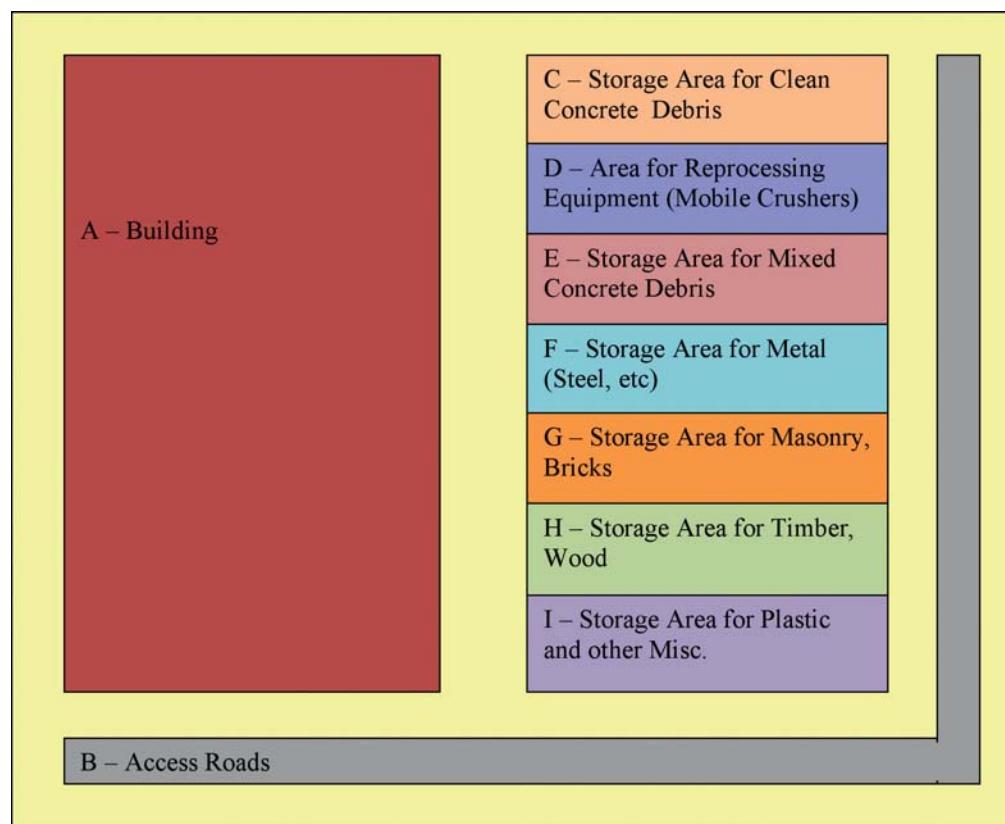
- a. Demolition of part of building structures with higher concrete content (such as concrete parapet walls, etc)
- b. Stripping of deleterious materials (such as bricks, tiles, etc) which may contaminate clean concrete debris of building bearing structure.
- c. Step-by step demolition of bearing and main structure by dismantling part of structures of similar materials to avoid contamination of clean concrete debris and allow separation of concrete debris from other demolition waste.

## **3. Site Waste Management Plan**

All demolition materials should be separated into different groups e.g. concrete, bricks, metals, wood/timber, etc. To facilitate sorting, a site waste management plan is required to allocate on-site temporary storage points for each material generated from the demolition before disposal to an accredited recycling facility for processing into recycled products.

See Annex for more details of each stage of demolition protocol.

### **Sample of Storage Area for Waste Segregation On-Site**



## DEMOLITION CHECKLIST FOR RESOURCE RECOVERY

### 1. Before Demolition: Pre-Demolition Audit & Method Statement

- Obtain set of building plans of structures to be demolished.
- Assess construction method, structural framing system, and critical building elements that need special treatment during sequential demolition.
- Assess types of material used in the construction of the building through desk study of building blueprint and site visits.
- Conduct Pre-Demolition Audit by:
  - Identifying types of waste that can be recycled e.g. concrete, bricks, metals, wood/timber, etc
  - Calculating respective quantity of demolition waste to be generated
  - Setting targets for maximum resource recovery of demolition waste
- Develop Method Statement for Sequential Demolition by:
  - Identifying part of building structures with higher concrete content (such as concrete parapet walls, ground slabs, carparks, etc)
  - Establishing most effective demolition sequence to reclaim clean concrete without cross contamination with other waste materials such as bricks, timber, etc. State clearly the sequence of demolition of structural elements on each floor, i.e. parapets, brickwall, slabs, beams, columns, walls, etc
  - Identifying existing fixtures and fittings that may affect the demolition progress and need to be removed prior to commencement of demolition works (such as false ceiling, air conditioning units, doors, wooden floors, partitions, ceilings, windows, and other mechanical services).
  - Identifying potential removal of materials which may contaminate the clean concrete debris (such as bricks, tiles, etc) and the level of material segregation sorting required.
- Develop Method Statement for Site Waste Management Plan by:
  - Measuring the available working spaces on-site for waste segregation based on site constraints
  - Drawing up site plan of the building/structures to be demolished, indicating available temporary storage space for different types of waste materials, and feasibility for mobile/on-site recycling
  - Planning of traffic route for debris handling, including provision of lorry car parks

### Deliverables

- Submit a Pre-Demolition Audit which identify waste types and quantities
- Establish recovery/recycling target (e.g. 70% recovery rate of the concrete waste quantity declared)
- Submit a method statement for Sequential Demolition specifying clearly the order of demolition with realistic schedule to deliver the specified target without compromising safety
- Submit a method statement for Site Waste Management Plan to achieve proper waste segregation on-site

## 2. During Demolition

### **Phase 1:** (*can be done before demolition commences*)

- Removal of existing fixtures and fittings (such as false ceiling, air conditioning units, doors, wooden floors, partitions, ceilings, windows, and other mechanical services).
- Stripping of deleterious materials which may contaminate the clean concrete debris of building bearing structure (such as bricks, tiles, etc).

### **Phase 2: Sequential Demolition**

- Demolition of the bearing and main structure to be progressed in conformance with the method statement approved by the Qualified Person
- Demolition of part of the building structures with higher concrete content (such as concrete parapet walls, etc)
- Step-by step demolition of the bearing and main structure by dismantling part of the structures that are of similar materials to avoid contamination of clean concrete debris and allow separation of concrete debris with other demolition waste

### **Phase 3: Site Waste Management Plan**

- Separation of demolition debris into different groups (such as concrete, bricks, metals, wood/timber, plastic, etc).
- Proper labeling and storage of sorted waste generated in the demolition process

#### **Deliverables**

- Production of cleaner quality of concrete demolition waste on-site
- Establish temporary storage areas for various categories of waste generated in the demolition process

## 3. After Demolition: Book-keeping

- Record details of debris disposal in terms of the amount and types of demolition waste generated weekly from the site
- Record details of debris management system and the movement of the waste from the site (either used for hardcore, or for road access, or sent to an approved disposal facility and/or accredited recycling facilities for further processing into recycled products and aggregates for beneficial reuse/recycling)

#### **Deliverables**

- Submit details of debris disposal and management system
- Evaluation of resource recovery and recycling target from demolition wastes

## APPENDIX: Green & Gracious Builder Scheme Criteria

### Summary of Assessment Criteria

Criteria	Points Available
<b>(A) Green Practices</b>	<b>50</b>
Company Policy	5
Materials (Reduce/Reuse/Recycle)	19
Energy	12
Environmental/Water	9
Housekeeping & Air Quality	5
<b>(B) Gracious Practices</b>	<b>40</b>
Company Policy	4
Accessibility	4
Public Safety	7
Noise & Vibration	9
Communication	7
Workforce Management	9
<b>(C) Innovation</b>	<b>10</b>
<b>Total</b>	<b>100</b>
<i>Plus: Bonus Points</i>	<i>5</i>
<b>Total Possible Points</b>	<b>105</b>

## GREEN PRACTICES (50%)

(A) Green Practices		Total: 50
Company Policy		Subtotal: 5
Procedure/Planning	Does the builder have procedures to inculcate and raise awareness of green best practices to all levels of staff? i.e. a) Management and Professionals b) Site supervisors c) Workers	2 pts
	Has the builder set specific goals and KPIs to address the various factors: a) Reduce/Reuse/Recycle b) Energy c) Environmental/Water d) Housekeeping & Air Quality	2 pts
Practices	Does the builder include “Green” as one of the considerations when selecting its suppliers and subcontractors?	1 pt
Reduce/Reuse/Recycle		Subtotal: 19
Procedure/Planning	Has the builder put in place procedures or measures to encourage recycling or reduction of construction waste and office waste?	3 pts
	Is there a monitoring system of wastage on site?	1 pt
KPI	Performance rating of waste on site a) Concrete Wastage b) Rebar Wastage c) Waste Disposal Cost - proxy to amount of waste generated	4 pts
Technology	Is there any use of systems and technology to reduce waste: a) Formwork systems to reduce use of Timber (2 pt) b) Platform systems (to reduce use of scaffolding) (2 pt) c) Use alternative methods or systems to reduce masonry work (2pt)	6 pts
Practices	Are there use of recycled and sustainable materials for non-structural applications? (e.g. cement replacements, aggregate replacements, etc)	5 pts

<b>Energy</b>		<b>Subtotal: 12</b>
Procedure/Planning	Is there a monitoring system for energy consumption on site?	1 pt
KPI	Performance Rating of energy consumption. KPIs include a) electricity consumption (For sites using AC Power) b) Diesel consumption (For sites using Diesel Generators)	3 pts
Technology	Is there any use of energy-saving/efficient or “Green Label” appliances, equipment and/or devices? (both site and office environment)	4 pts
	Is there use of alternative energy/fuels (e.g. solar for site office, biodiesel for construction plant)?	2 pts
Practices	Do the sites use AC grid power supply instead of diesel generators?	2 pts
<b>Environmental/Water</b>		<b>Subtotal: 9</b>
Procedure/Planning	Is there monitoring of usage of water on site?	1 pt
KPI	Performance Rating of water consumption	2 pts
	Performance Rating of Total Suspended Solids (TSS) Readings	2 pts
Technology	Does the builder have water saving or recycling equipment or devices (both site and office) to conserve water usage? E.g. Equipment to treat and recycle water for non-portable/construction use?	3 pts
Practices	Does the builder use environmentally friendly products (e.g. pesticides, cleaning products, etc) for its office and sites?	1 pt

<b>Housekeeping &amp; Air Quality</b>		<b>Subtotal: 5</b>
Procedure/Planning	Are there any in-house procedures to encourage good housekeeping in construction sites?	1 pt
	Has the builder adopted measures to address dust generated from material storage and vehicles?	1 pt
	Has the builder adopted measures to address rubbish and refuse accumulation and collection?	1 pt
Practices	Are there planned regular maintenance of construction vehicles and machinery to reduce emission rates?	1 pt
	Does the builder appoint a designated site personnel or controller to oversee housekeeping and cleanliness on site?	1 pt

## GRACIOUS PRACTICES (40%)

<b>(B) Gracious Practices</b>		<b>Total: 40</b>
<b>Company Policy</b>		<b>Subtotal: 4</b>
Procedure/Planning	Does the builder have an established policy to adopt gracious practices? Is the plan endorsed by top management?	2 pts
	Does the builder have procedures to inculcate and raise awareness of gracious best practices to all levels of staff? i.e. a) Management and Professionals b) Site supervisory c) Workers	1 pt
	Does the builder have procedures in place to address (with regards to gracious practices): a) Continual improvement and feedback to management and site staff b) Communicating such procedures and requirements to suppliers and subcontractors	1 pt

<b>Accessibility</b>		<b>Subtotal: 4</b>
Practices	Are the site accesses well signed? Is the access/entry into site generally clean and unobstructed?	1 pt
	Has consideration been given to accessibility wheelchairs (e.g. use of temporary ramps)?	1 pt
	Does the builder adopted measures to address possible causes of traffic obstruction?	1 pt
	Has the builder put in efforts to ensure sufficient and good signages around the construction site (For both motorists and pedestrians?)	1 pt
<b>Public Safety</b>		<b>Subtotal: 7</b>
Practices	Does the site provide covered walkways around site (for passageways which are used heavily by general public)?	1 pt
	Are the hoarding and walkways sufficiently designed, well-maintained and in good condition?	1 pt
	Do the sites provide full-height safety netting and catch platform to mitigate risk of falling debris?	1 pt
	Has consideration being given to the provision of footpaths? E.g. 1) Is the width of the footpath/passage ways sufficient to cater for pedestrian volume/demand? 2) Is there provision of alternate footpath when the existing footpath or walkway is being used for the construction works?	1 pt
	Are vehicular barriers provided for passageways located close or next to roads? (Public safety)	1 pt
	Is site safety information made clear to visitors on site? (Safety information could include the dos and don'ts on site, fire safety evacuation information, etc	1 pt

Practices	Are there comprehensive assessment and monitoring of surrounding buildings?	1 pt
<b>Noise &amp; Vibration</b>		<b>Subtotal: 9</b>
Procedure/Planning	<p>Does the builder set specific goals and KPIs to address the various factors:</p> <ul style="list-style-type: none"> <li>a) Noise</li> <li>b) Vibrations</li> </ul>	1 pt
	Does builder have procedures and standards to manage the piling subcontractors in terms of noise and vibrations?	1 pt
	Are there any efforts done to minimise noise disturbance through careful scheduling of noisy activities?	2 pts
	<p>Has the builder put in place operational procedures to mitigate noise and vibrations?</p> <ul style="list-style-type: none"> <li>a) Any efforts carried out to plan and locate noise source (e.g. vehicles, generators, etc) away from residents?</li> <li>b) Any procedures to ensure that construction plant &amp; machinery are properly maintained? (e.g. fasten loose panels, replace defective silencers, etc)</li> <li>c) Any efforts to train workers to handle materials carefully to reduce impact noise?</li> </ul>	1 pt
	Does the builder have procedures, measures and/or rules to mitigate tissues arising from night and/or weekend construction works (where applicable)	1 pt
Technology	Is there any use of measures or alternative construction methods/ machines to address noise and vibrations?	2 pts
Practices	Does the builder install noise and vibration meters both on and off site? (E.g. at neighbouring property/building)	1 pt

<b>Communication</b>		<b>Subtotal: 7</b>
Procedure/Planning	Does builder have a policy on public communications to residents/tenants (businesses)/town councils around construction site?	1 pt
Practices	Does the builder send out letters to neighbouring residents to inform of key milestones or major works?	1.5 pts
	Is there a designated hotline for public to call? Do the banner and posters contain the hotline number?	1 pt
	Are the banners and posters clearly visible to public?	0.5 pt
	Does the site have a designated person to handle complaints and feedback and to coordinate with the project staff to improve the site activities?	1 pt
	Does the builder have guidelines and documents on the handling of feedback cases?	1 pt
	Does the builder adopt measures or procedures to minimise security concerns of neighbouring residents? Examples may include: 1) Encouraging workers participate in the “Workers on Watch” (WOW) programme administered by SPF. 2) Out of office security arrangements in place to mitigate security concerns when the site is not in operation.	1 pt
<b>Workforce Management</b>		<b>Subtotal: 9</b>
Practices	Are site personnel and sub-contractors familiarised with the Award and what this means?	1 pt
	Does the company show consideration and provide welfare to the workers?	3 pts

Practices	<p>Does the builder have a system to manage their workers? Examples may include:</p> <ol style="list-style-type: none"> <li>1) Briefing of workers on dos and don'ts in and around site (e.g. behaviour around site, no loitering in public spaces)?</li> <li>2) Setting up of disciplinary procedures.</li> <li>3) Instructions clearly presented to workers, e.g. through handbooks.</li> </ol>	2 pts
	Has the builder achieved safety results better than the industrial average (based on AFR and ASR statistics)?	1 pt
	Does the builder have procedures, measures and/or rules to enhance on-site living conditions and mitigate issues which may arise from on-site housing (where applicable)	2 pts

## INNOVATION (10%) AND BONUS POINTS (5%)

Others	Total: 10
<b>Innovation</b>	
Has the builder adopted procedures or innovative use of technology and/or special construction methods to address environmental concerns, site challenges and/or to minimise the concerns of the public?	10 pts
<b>Bonus Points</b>	
<b>Awards</b>	
Has the builder received recognitions and/or awards (both public and private sector) in recognition of its outstanding performance/achievements?	Up to 5 points
<ol style="list-style-type: none"> <li>1) No. of completed projects certified under Green Mark Gold Plus and above.</li> <li>2) Awards [2 points per environmental related awards, 1 point for other awards]</li> </ol>	

## References

1. Considerate Constructors Scheme by Construction Umbrella (Holdings) Ltd, United Kingdom.
2. Engineering News Record (ENR) Ranking of Green Contractors by ENR Magazine.
3. Considerate Construction Site Award by Environment, Transport and Works Bureau, Hong Kong.
4. Green Contractors Award by Architectural Services Department, Hong Kong Special Administrative Region Government.
5. Comprehensive Environmental Performance Assessment Scheme for Buildings by Buildings Department, Hong Kong Special Administrative Region Government.
6. Guidebook on Erosion And Sediment Control At Construction Sites by Singapore Contractors Association Ltd and Public Utilities Board.
7. Best Environment Practices:- Noise Control at LTA Sites by Land Transport Authority
8. Singapore Standard SS ISO 14001:2004 Environmental Management Systems – Requirements.

## NOTES

## NOTES





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