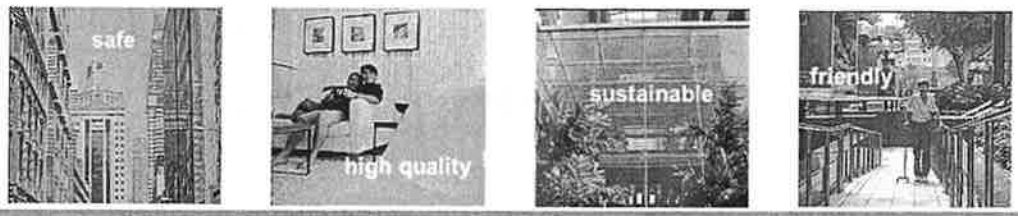
Sustainable Construction & Recycled Materials

http://www.bca.gov.sg/SustainableConstruction/others/sc_recycle_final.pdf
Email: low_giau_leong@bca.gov.sg; DID: 62489898



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AIM of MODULE

- To introduce sustainability concepts, types of materials that could be recycled
- To view industrial by-products as raw materials to be tapped on rather than waste to be disposed off
- To encourage adopting sustainable construction materials in the design & construction process

COURSE CONTENT

- Types of Waste
- Recycled Materials for Construction Work
- Road Usage
- Building Components Usage
- GM Related Information

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Introduction

- What's sustainability?

"To meet the needs of the present without compromising the ability of future generations to meet their own needs..."

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Understanding Sustainable Construction

1. **R**educe: reduce usage to conserve resources and materials, esp. non-replaceable ones
2. **R**euse: use back materials for same or similar purpose without further treatment
3. **R**ecycle: use back materials with some forms of treatment



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Understanding Sustainable Construction

- Reduce waste; use of natural resources
- Reduce GHG (greenhouse gas) emissions
- Use alternative materials (eg metal, glass, milled waste, slag, excavated earth etc) for building components
- Use recyclable materials (eg GGBS, FA, RCA) in concrete production and civil engineering works

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BCA's Strategic Thrusts

- Replace conventional concrete with sustainable alternatives
  - through use of steel, high strength concrete etc
- Reduce demand for natural materials such as sand and granite
  - through adoption of alternative recycled materials

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Types of Waste

- Waste generated as a result of commercial and industrial activities
  - eg. paper, plastic, wood, spent copper slag; steel slag, sludge/industrial waste; incineration ash; dredged material etc

Types of Waste

- Waste generated by construction activities
  - Construction waste &
  - Demolition waste

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Types of Waste



Construction Waste



Demolition Waste

National Environment Agency

Waste Statistics and Overall Recycling

Waste Statistics and Recycling Rate for 2012

Waste Type	Waste Disposed of (tonnes)	Total Waste Recycled (tonnes)	Total Waste Output (tonnes)	Recycling Rate (%)
Construction Debris	9,100	1,282,700	1,291,800	99
Used Slag	9,800	358,000	367,800	97
Ferrous Metals	54,800	1,331,200	1,386,000	96
Scrap Tyres	2,300	16,100	18,400	88
Non-Ferrous Metals	25,200	97,300	122,500	79
Wood/Timber*	107,800	236,000	343,800	69
Paper/Cardboard	555,300	696,700	1,252,000	56
Horticultural* Waste	139,800	108,000	247,800	44
Glass	55,400	19,500	74,900	26
Food Waste	618,100	85,100	703,200	12
Textile/Leather	141,000	18,300	159,300	11
Plastics	721,300	82,100	803,400	10
Others (Stones, Ceramics & Rubber)	333,800	4,600	338,400	1
Sludge	160,200	0	160,200	0
Total	2,933,900	4,335,600	7,269,500	60

*Includes 110,300 tonnes used as fuel in biomass power plants

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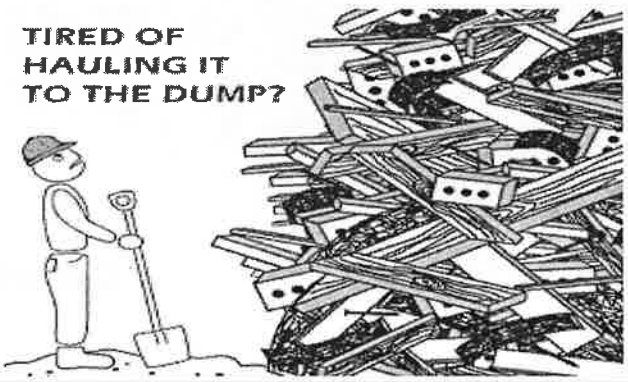
Recycled Materials for Construction Work

- Potential raw materials to be tapped on rather than waste to be disposed off- *not necessarily inferior*



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Recycled Materials for Construction Work



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Recycled Materials for Construction Work



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Recycled Materials for Construction Work



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Recycled Materials for Construction Work



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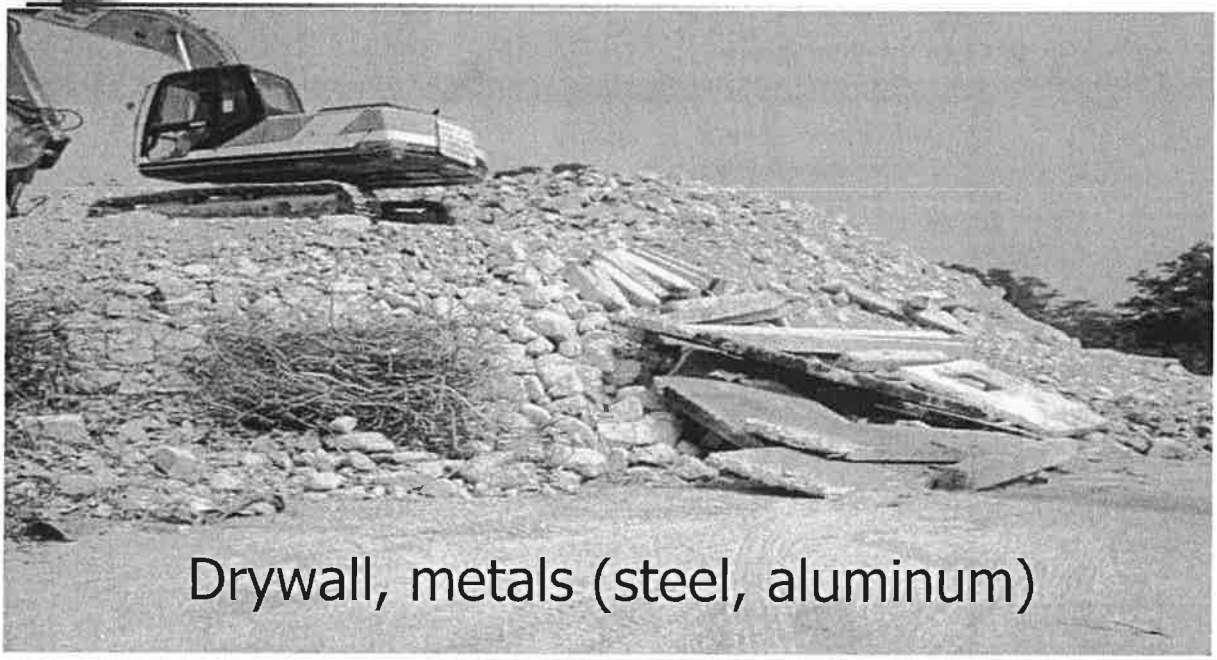
Recycled Materials for Construction Work



Drywall, metals (steel, aluminum)

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Recycled Materials for Construction Work



Dredged material

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Funding for SC Related Projects



Key Focus Areas

Target Groups	Areas of Focus
Demolition Contractors	*Waste mgmt & recovery*
Waste Recyclers	*SC practices & technologies*
RMC Suppliers	*Env-friendly products & innovation*
QPs & Contractors	*SC Materials*

R&D done by local companies*

- Engineered Agg. from dredged marine clay
- Engineered Agg. from Demolition Waste- RCA (Recycled/Reclaimed Congrete Agg) from crushed concrete
- Engineered Agg. from Incineration Bottom Ash
- Engineered Agg. from washed copper slag

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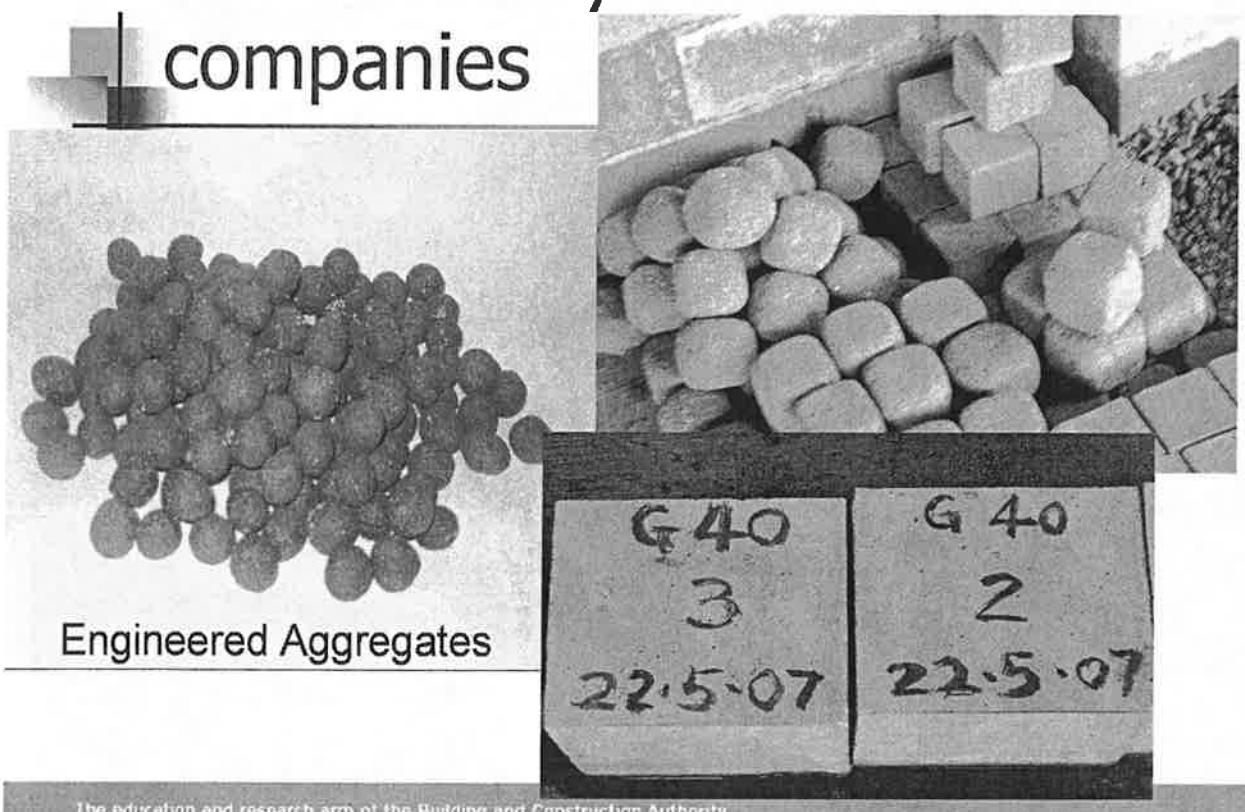
R&D done by local companies



Engineered Aggregates

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新科技 新商机

化海泥为建材

海港局将展开为期一年的试验计划，探讨新科技是否适用于再循环大量的海泥，进行大规模生产。试验计划料在今年底展开。

黄佩玲 ■ 报道

为了使海港航道保持一定深度，海事及港务管理局每年从海底，挖出数量惊人的海泥。现在，这些经常必须丢回海里的泥沙废料，终于有机会"上岸"，成为有用的建筑材料。

可铺路或建大厦

海港局与南洋理工大学合作研发新科技，利用结晶法（crystallisation technology），把含铁和工业废料的海泥，再循环成泥土集料（aggregate），做为建筑用途，例如铺路或建筑大厦。

海港局接下来将展开为期一年的试验计划，探讨新科技是否适用于再循环大量的海泥，进行大规模生产。试验计划预料在今年底展开。

海港局回答本报询问时说，新加坡作为世界重要海港之一，海港局必须定期清理海底的海泥废料，确保海港保持足够的深度，方便船只航行。除了当局的定期挖泥工作，一些海底边的发展工程也切能制造废泥，当中包括不少含铁成分。

根据岸边的工程量而定，海港局每年所须处理的海泥，数量不一。前年，海港局挖掘出290万立方米的海泥，而在去年，海泥挖掘量达500万立方米。海港局也把我国水域的一些特定范围，做为埋置这些海泥的地方。

这是海港局首次尝试为海泥找"新出路"。发言人说，新加坡能埋置海泥的地方有限，回收海泥的计划也能为本地的再循环业带来新商机。

新科技前年起研发

南大研究员是在2001年开始研发新科技，研究员使用一种特别的化学制把含铁和有毒废料的海泥，结晶为一个不含有害成分的固体。之后，为了给结晶体多一层保护，研究员再以玻璃化法（vitrification process）来处理结晶体。

海港局发言人透露，在试验计划中，每一生产线在一年里可处理的海泥量达50万公吨，所生产出来的再生品可达60万吨。当局没有透露计划开发几个生产线。试验计划的其他合作伙伴包括荷大、德邦新业集团（Surbana Corporation）和NewEarth。

这项再循环科技也让海港局与另外3名合作伙伴，在今年的"21世纪公共服务计划追求卓越奖项"（PS21 ExCEL）中，赢得企业技术（创新）奖。



由海港局与南大研究员合作研发的海泥再循环科技，在今年的"21世纪公共服务计划追求卓越奖项"中赢奖。领奖者是（左起）南大研究员郑伯铭、陈盛隆和海港局科技著署署长杜亚祥。

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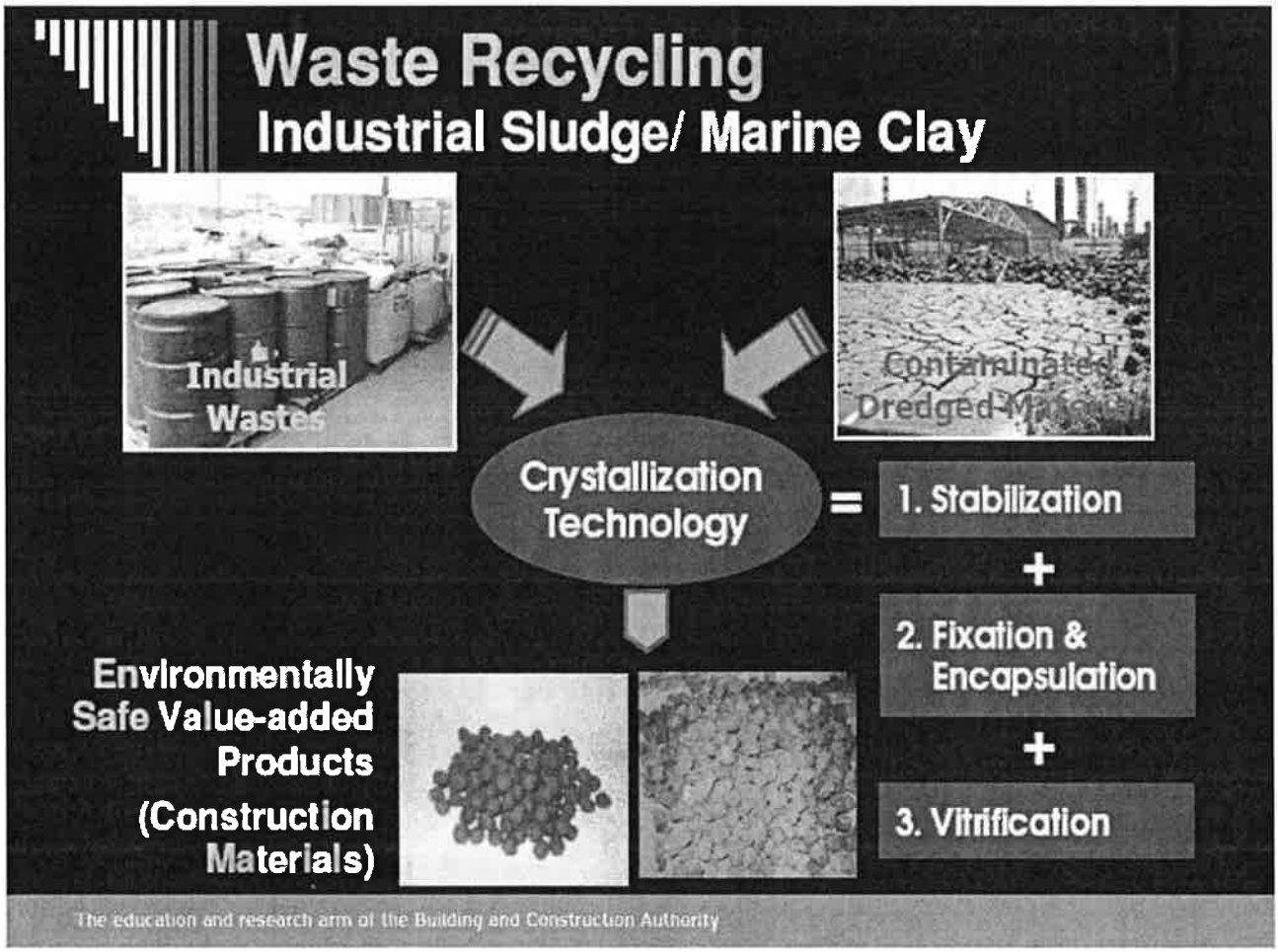
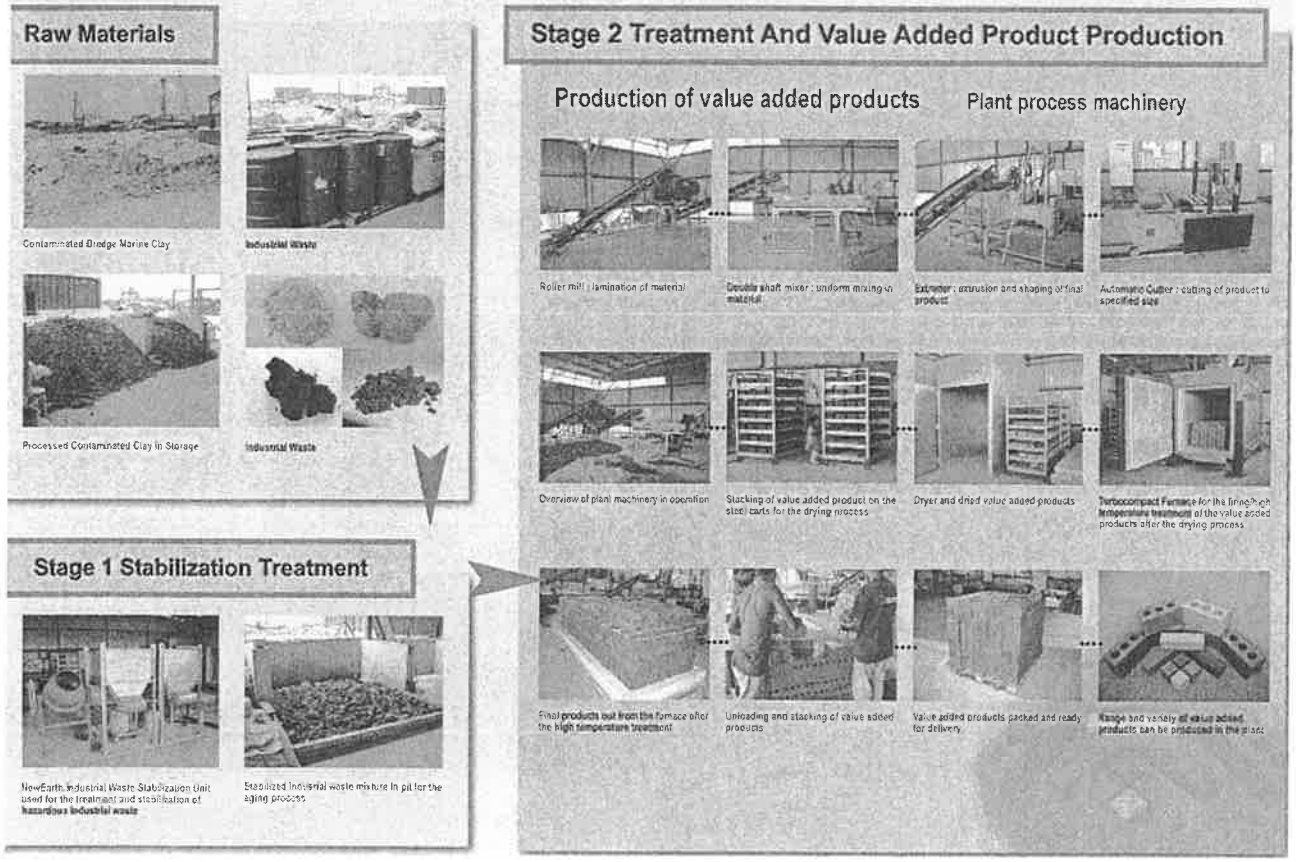


NewEarth Industrial Waste Reutilization Process



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R&D done by local companies

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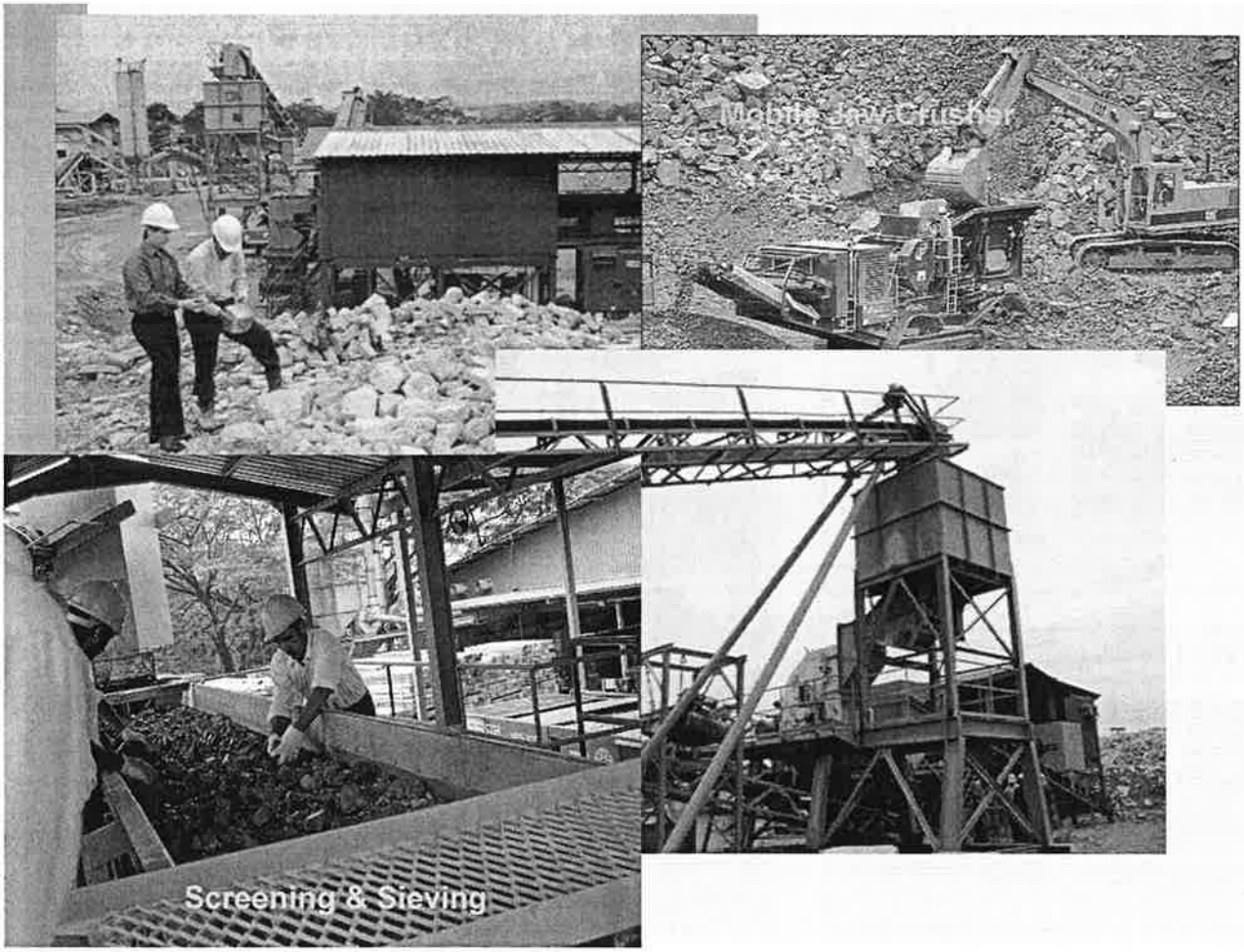
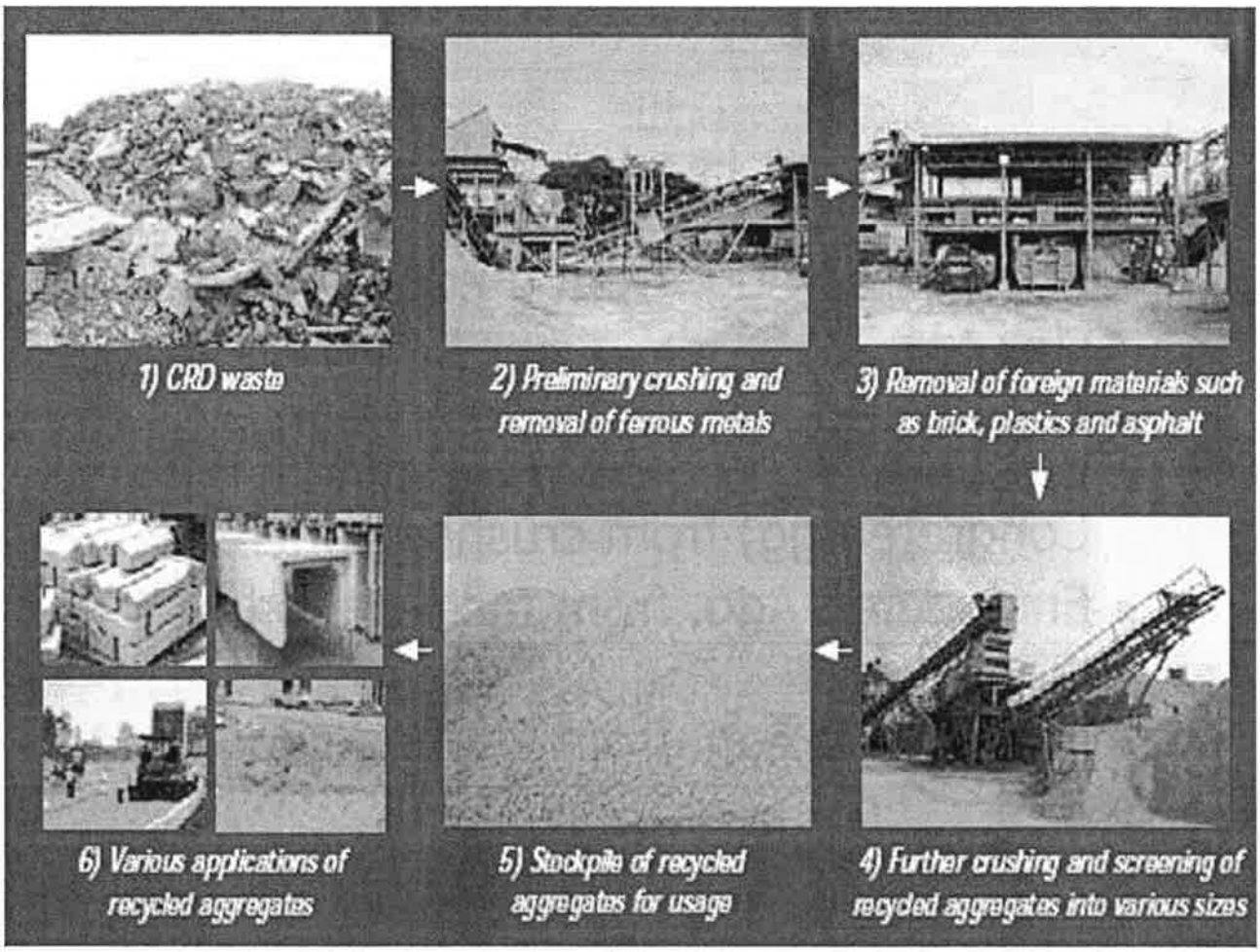
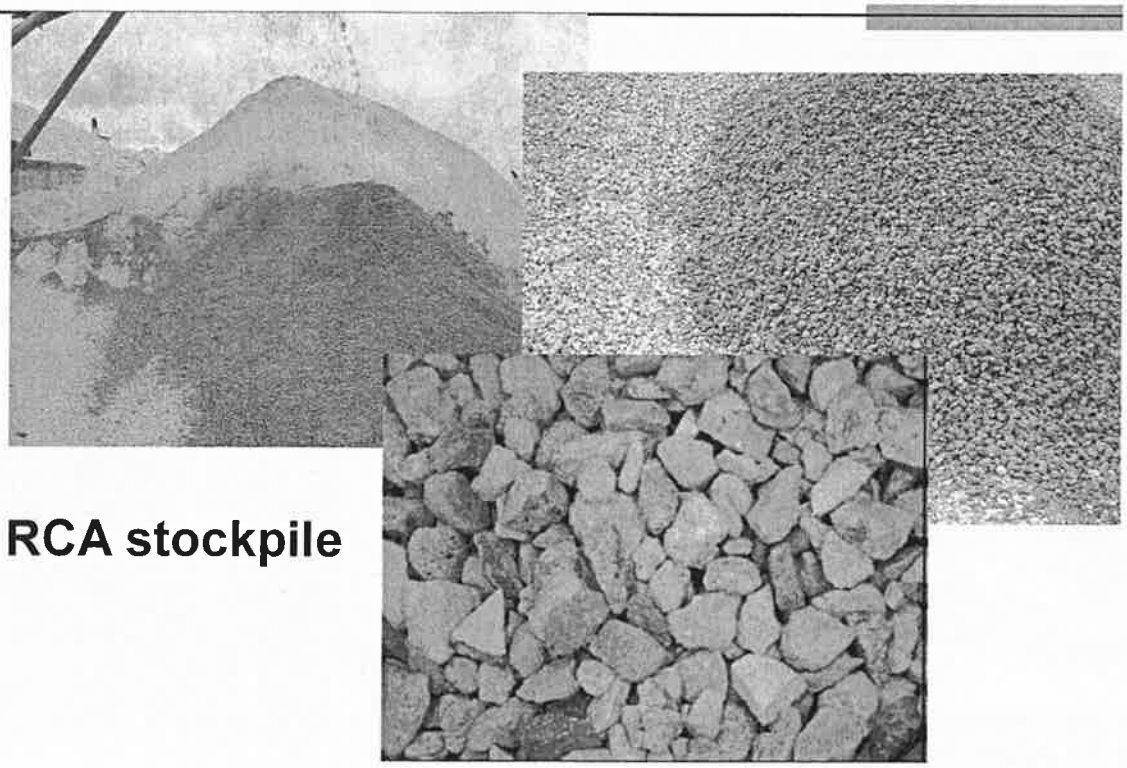
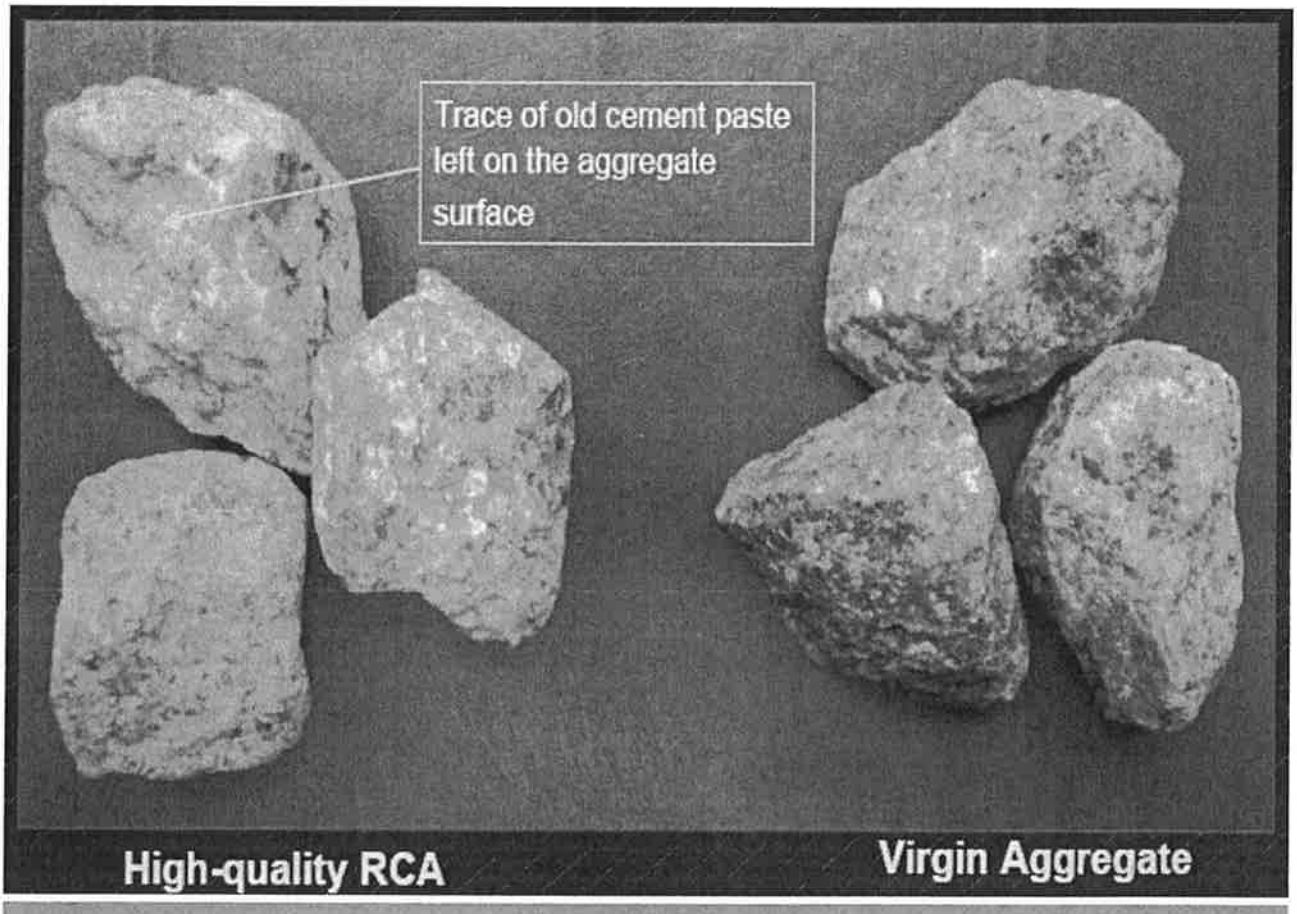

Mobile Jaw Crusher
Screening & Sieving


1) CRD waste
2) Preliminary crushing and removal of ferrous metals
3) Removal of foreign materials such as brick, plastics and asphalt
4) Further crushing and screening of recycled aggregates into various sizes
5) Stockpile of recycled aggregates for usage
6) Various applications of recycled aggregates

Production of RCA



RCA stockpile



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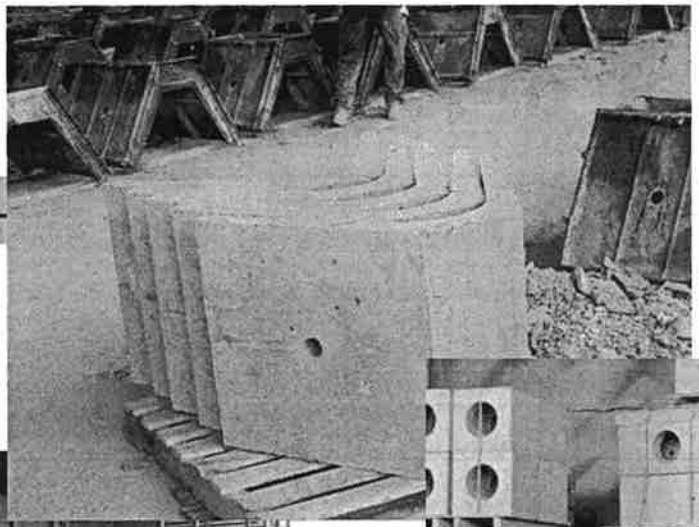
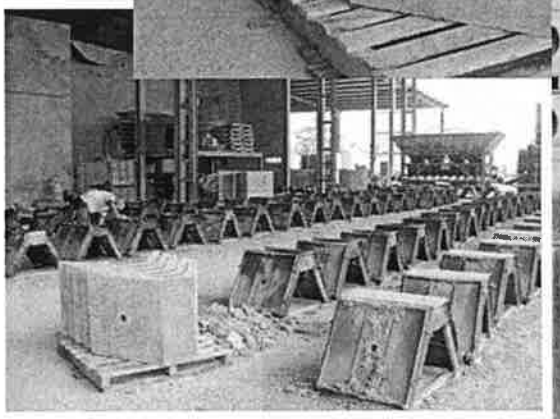
Precast Kerbs & Drains







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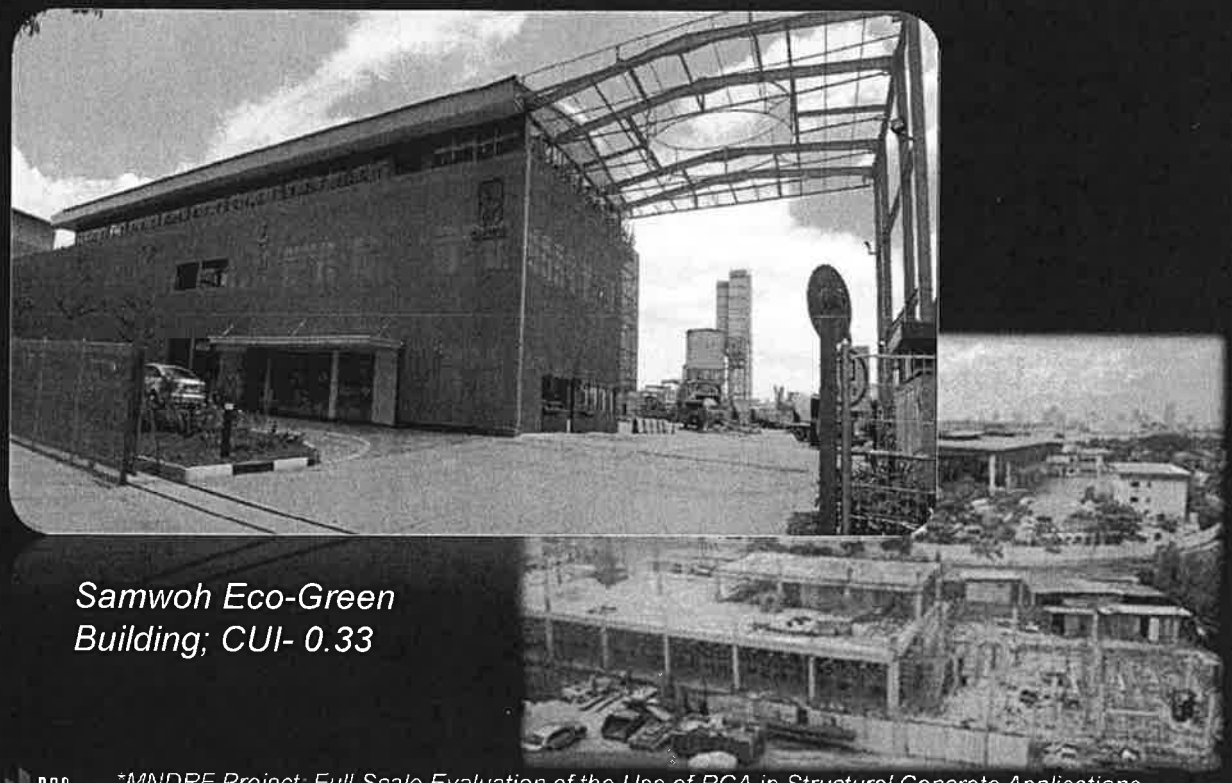
Projects using Recycled Materials



Projects using Recycled Materials



Samwoh Eco-Green Building; CUI- 0.33

**MNDRF Project: Full Scale Evaluation of the Use of RCA in Structural Concrete Applications*

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Projects using Recycled Materials



Woh Hup HQ Bldg; CUI- 0.46

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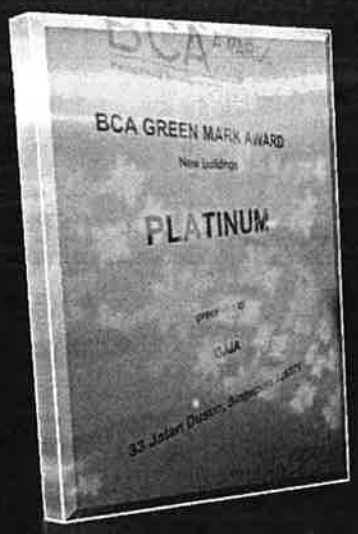
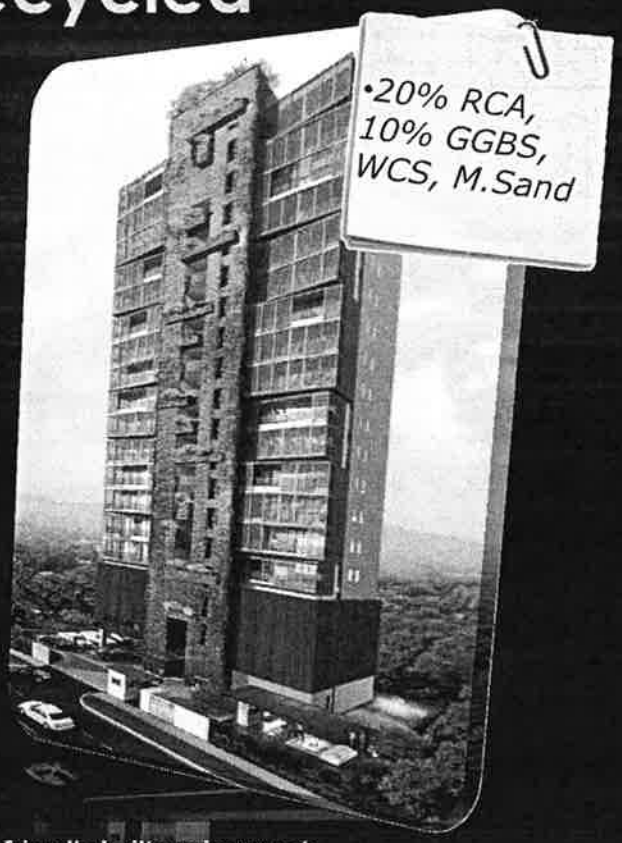
Projects using Recycled Materials



GAIA Building;
CUI- 0.42



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R&D done by local companies

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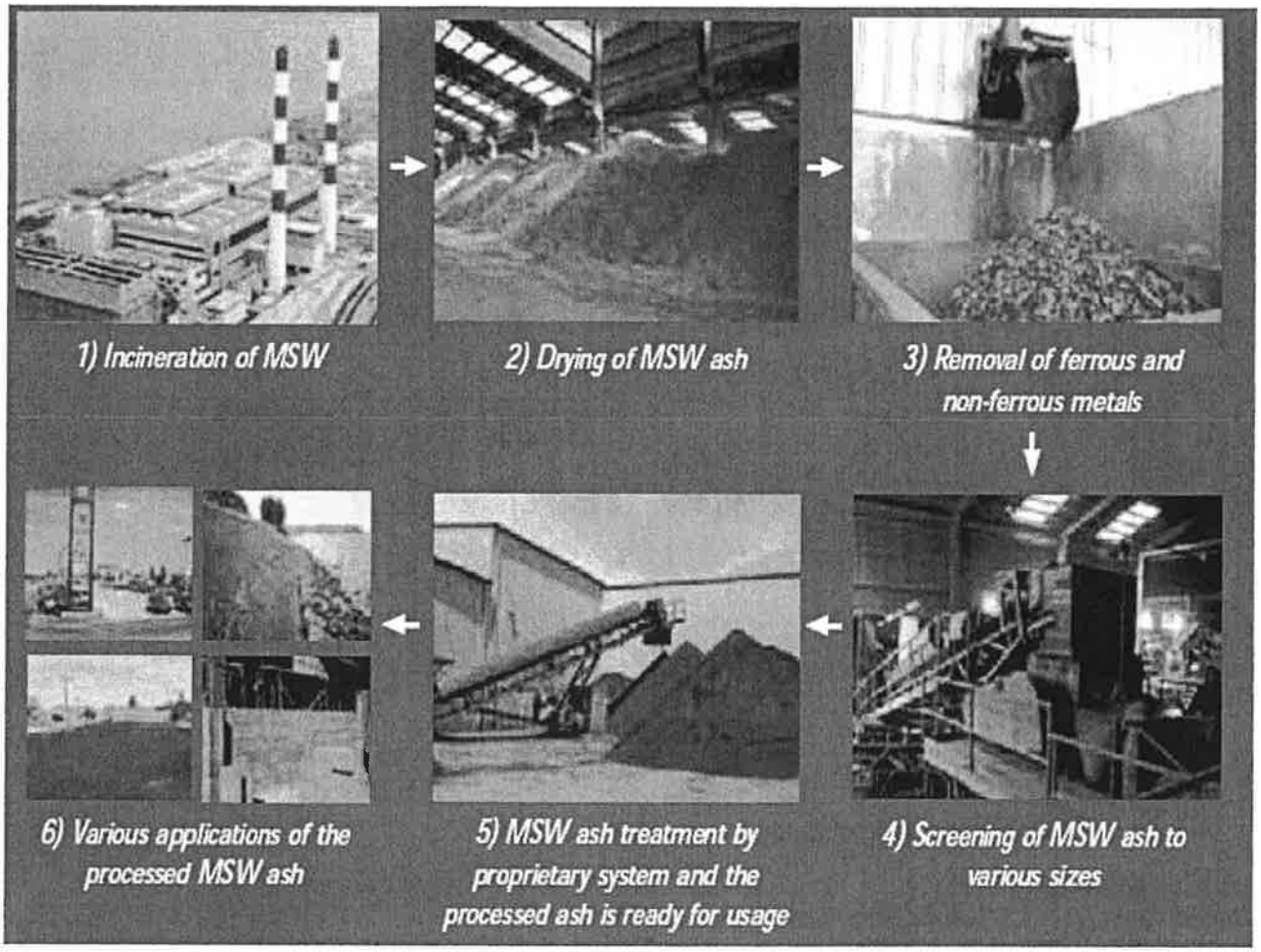
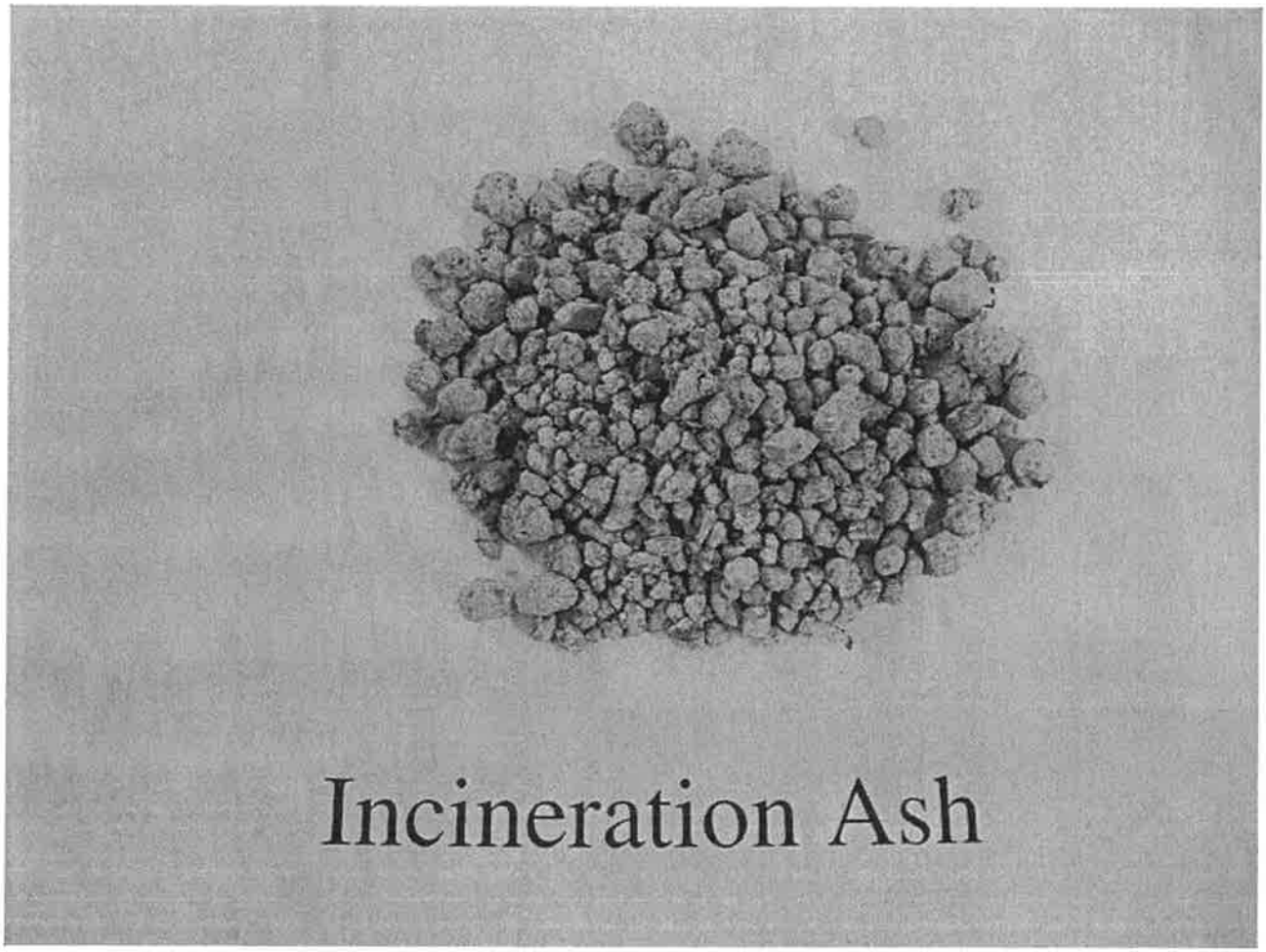

1) Incineration of MSW
2) Drying of MSW ash
3) Removal of ferrous and non-ferrous metals
4) Screening of MSW ash to various sizes
5) MSW ash treatment by proprietary system and the processed ash is ready for usage
6) Various applications of the processed MSW ash


Incineration Ash

R&D done by local companies

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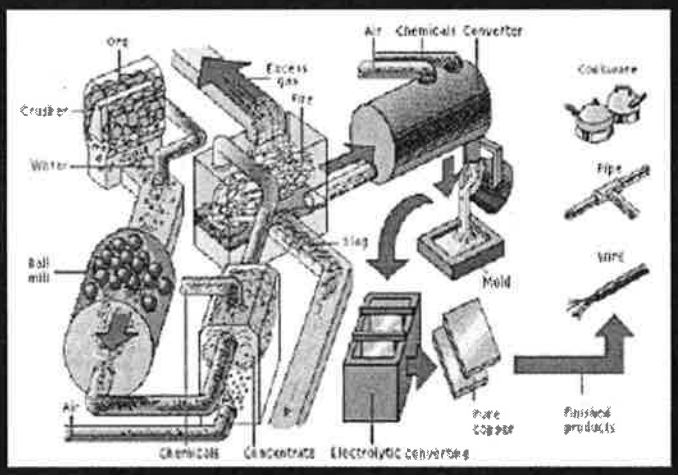
Waste Recycling
Copper Slag



- Copper slag is a by-product of copper production from copper ore.
- During smelting, a molten pool of copper forms at the bottom of the furnace while a layer of impure metal, which is the slag, is drained off from the top.

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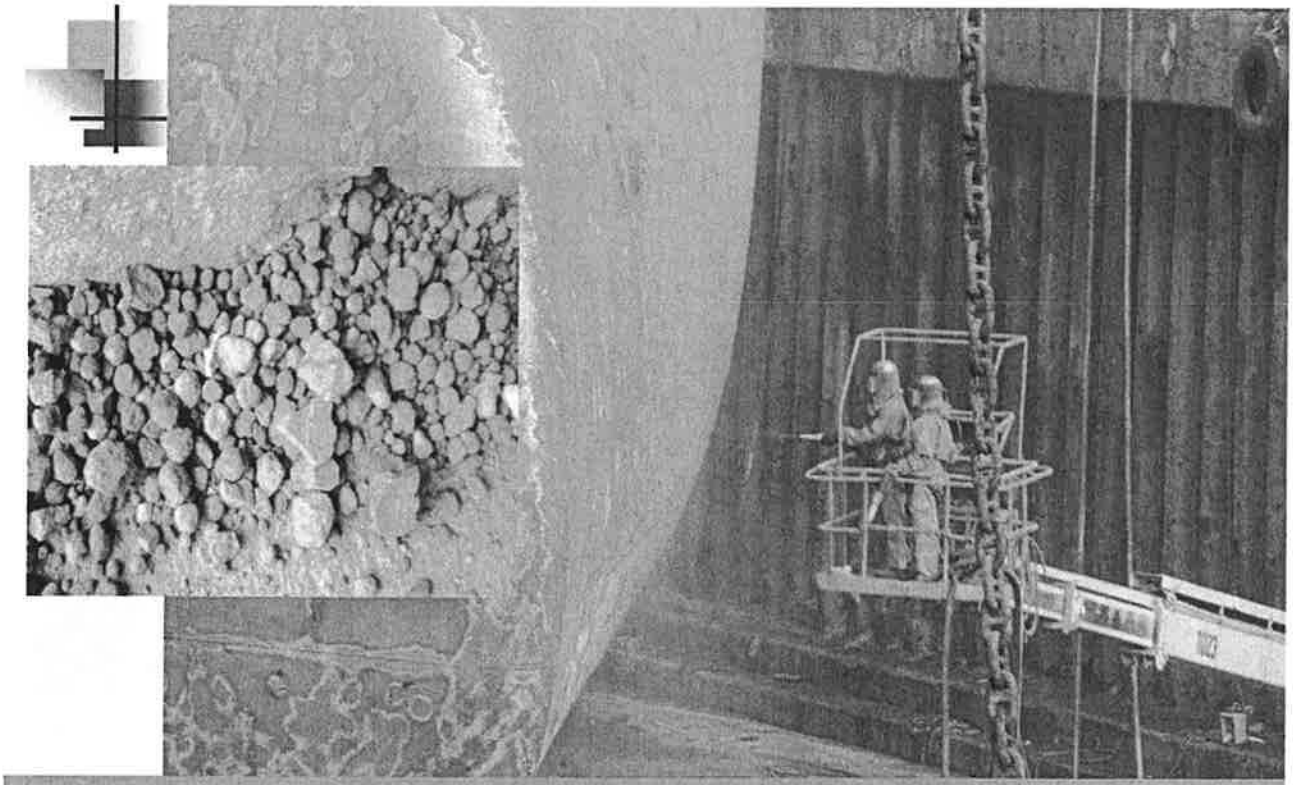

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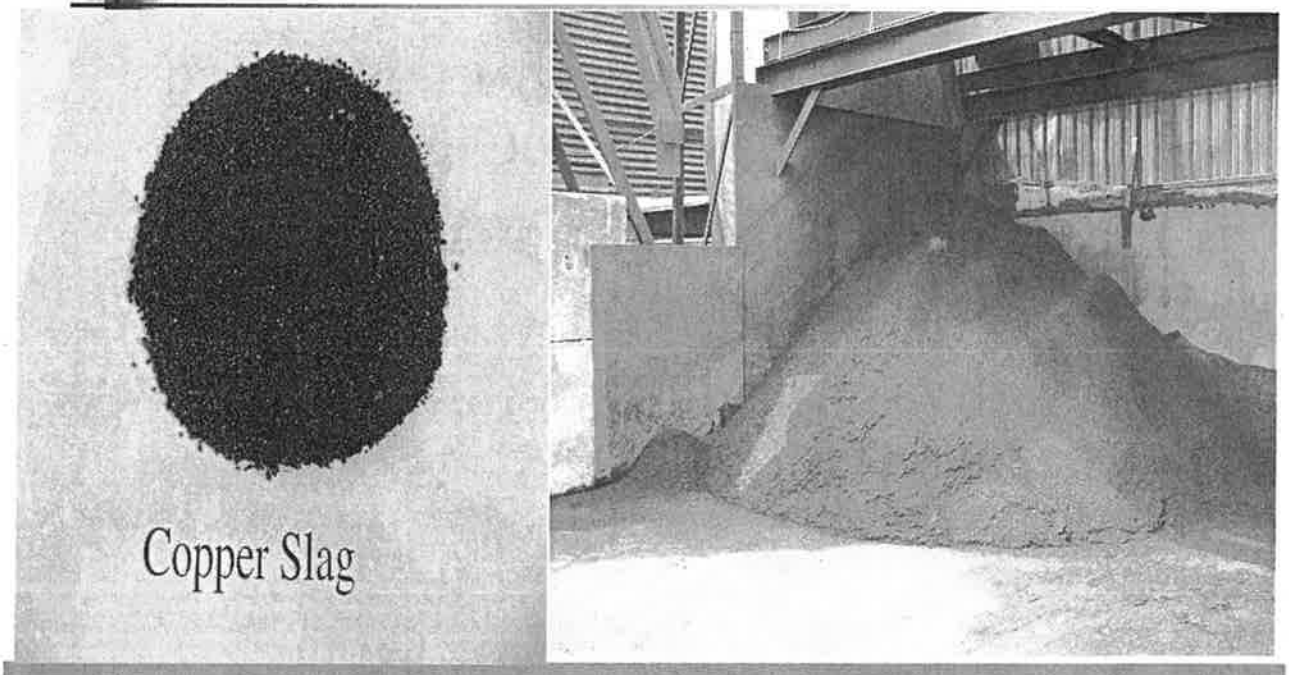

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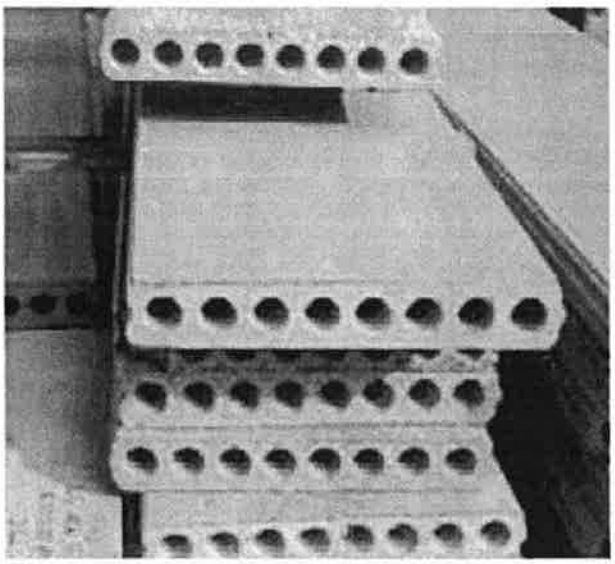
Precast kerb using copper slag



Precast concrete internal partition wall using copper slag

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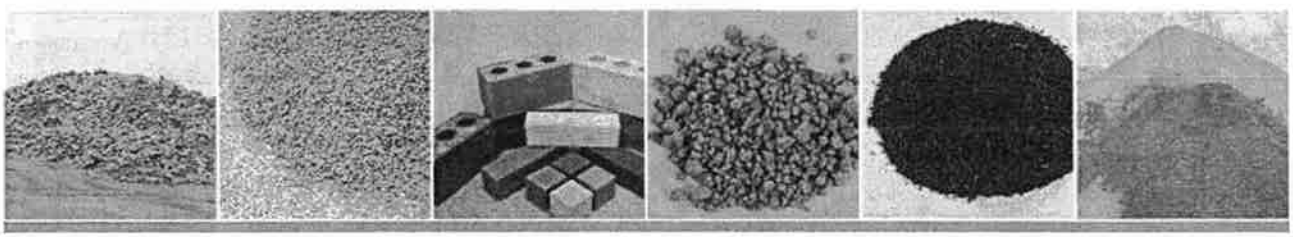
Trial/Pilot Projects

- NUS[1] & Tiong Seng Construction testing internal partition wall using RCA
- HDB used RCA for walkways, sec. roofing & non-structural slab
- Samwoh Asphalt- R&D of IBA for land reclamation[2] & roads



Trial/Pilot Projects

- LTA field trial on stretch of Jln Boon Lay using copper slag (2001)



A field trial section of LTA's road widening project on the use of pre-treated copper slag.

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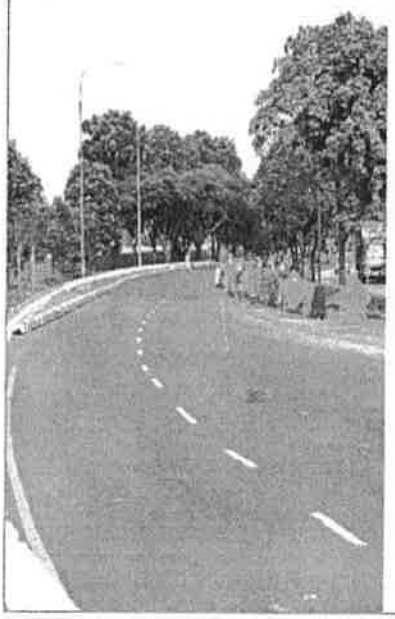
Trial/Pilot Projects



More than ash

Instead of the usual granite, a stretch of road in the Jurong Industrial Estate has as its base material, bottom ash from the Senoko Incineration Plant. The 150-metre stretch of Jalan Buroh was a pilot project.

The ash was aged for eight to ten weeks before use, to stabilise the materials. After aging, the ash was processed to remove ferrous and non-ferrous metals, and unburned materials. 1,200 tonnes of this ash was used as the road-base, which was then laid over with an asphalt mix.

The road has been in use since May 2002 and found to be safe. Monitoring of groundwater and surface quality shows that using the ash will not cause water pollution.

- IBA from Senoko IP for road base in Jurong Indust. Estate (2002)

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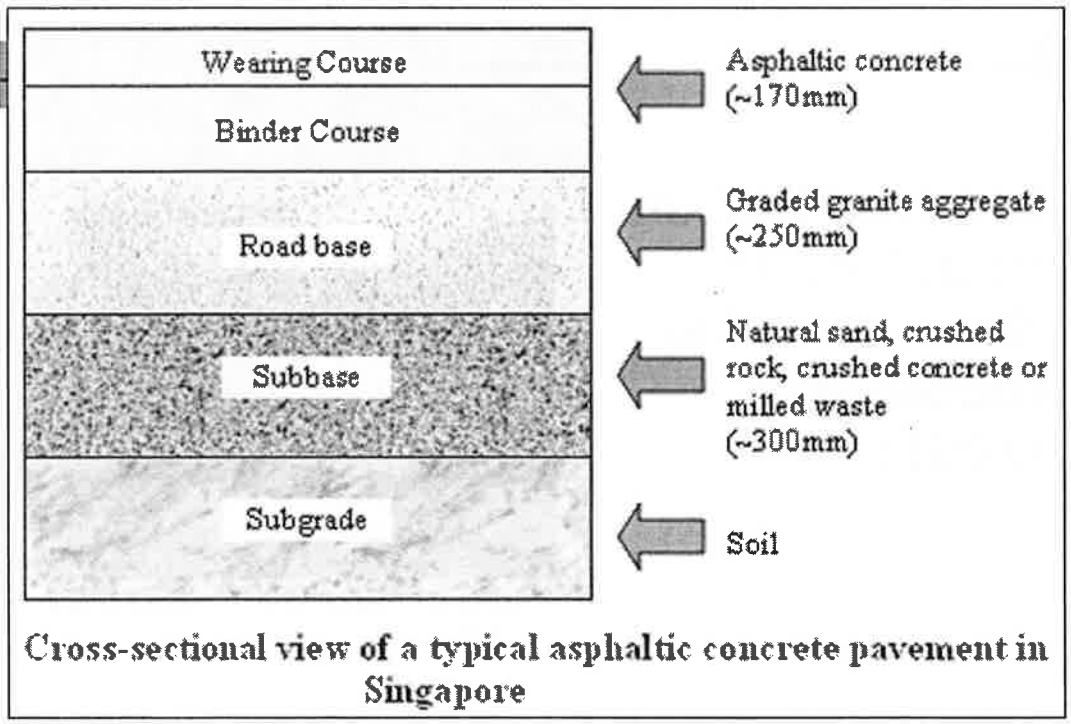
Typical asphalt concrete pavement



Cross-sectional view of a typical asphaltic concrete pavement in Singapore

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Trial/Pilot Projects

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Pilot project to build Singapore's "green" road kicks off

By Asha Popatlal, Channel NewsAsia | Posted: 10 March 2006 2057 hrs

SINGAPORE: A pilot project by the Land Transport Authority (LTA) to construct Singapore's "green" road using recycled materials has kicked off. If successful, it could lead to savings of millions of dollars annually.

Using recycled materials to build roads in Singapore is not new. It has been done for the last 20 years and about a quarter of the roads today have some form of recycled materials in them.

What makes the latest trial different is that a mix of recycled materials will now be used extensively in all four layers of the road structure, instead of just one layer as was done previously.

If the scheme works, the advantage is two-fold. Firstly, Singapore can reduce its dependence on the import of expensive raw materials like granite from neighbouring countries.

Secondly, it is cheaper to build such roads as one of the recycled materials used is waste generated within the country.

Household rubbish which has been burnt and processed is one material which will be used to construct the third and fourth layers of the road in the green pavement trial.

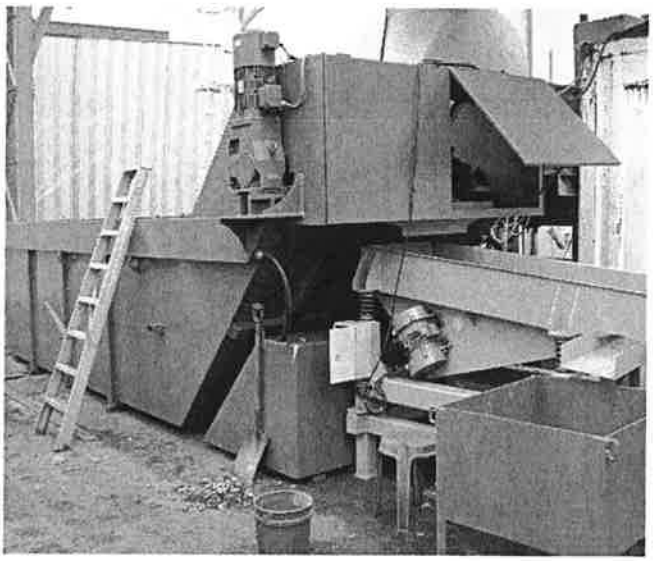


- IBA for base & sub-base of 'Green' Road

Today, an average of 2,000 tonnes of waste is dumped at the Semakau Landfill daily. If the waste can be used for roads, the amount dumped can be reduced by as much as half and the Semakau Landfill life-span extended by about 25 years.

Past R&D projects supported by BCA

- Waste concrete reclamation & wastewater recycling in concrete batching plant



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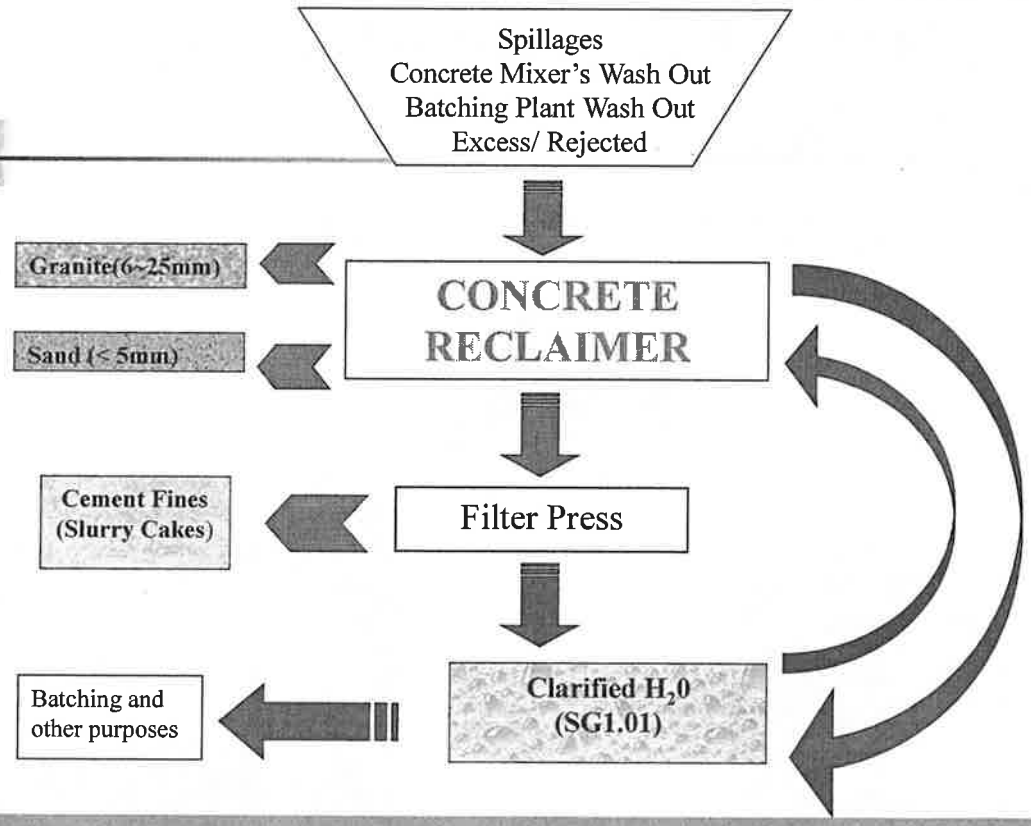

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Recycled Products



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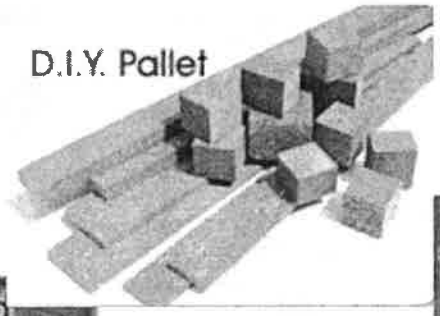
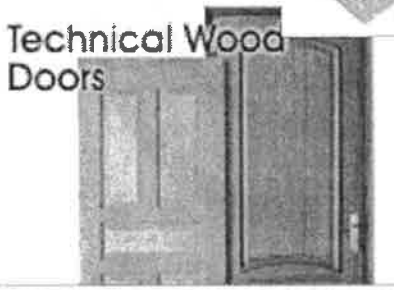
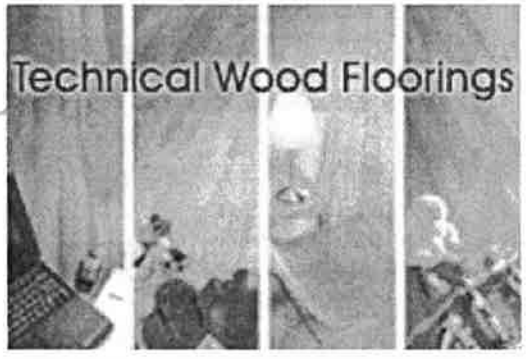
Past R&D projects supported by BCA

- Technical wood flooring







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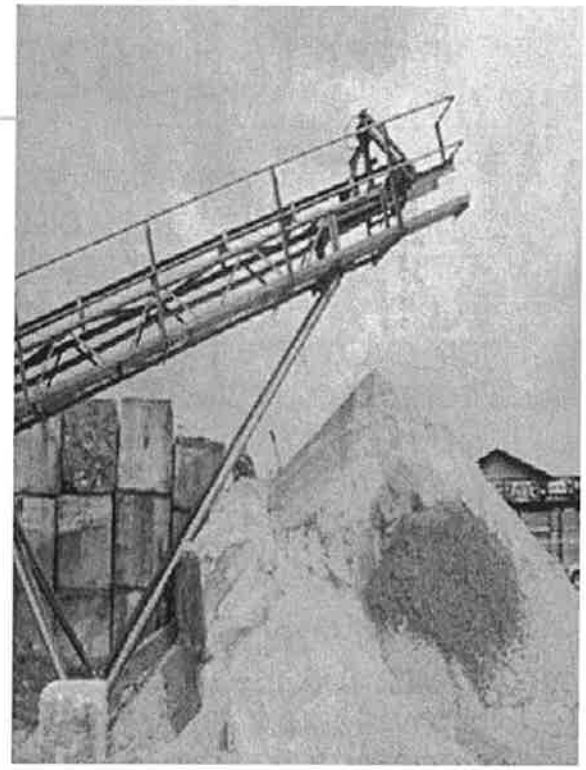
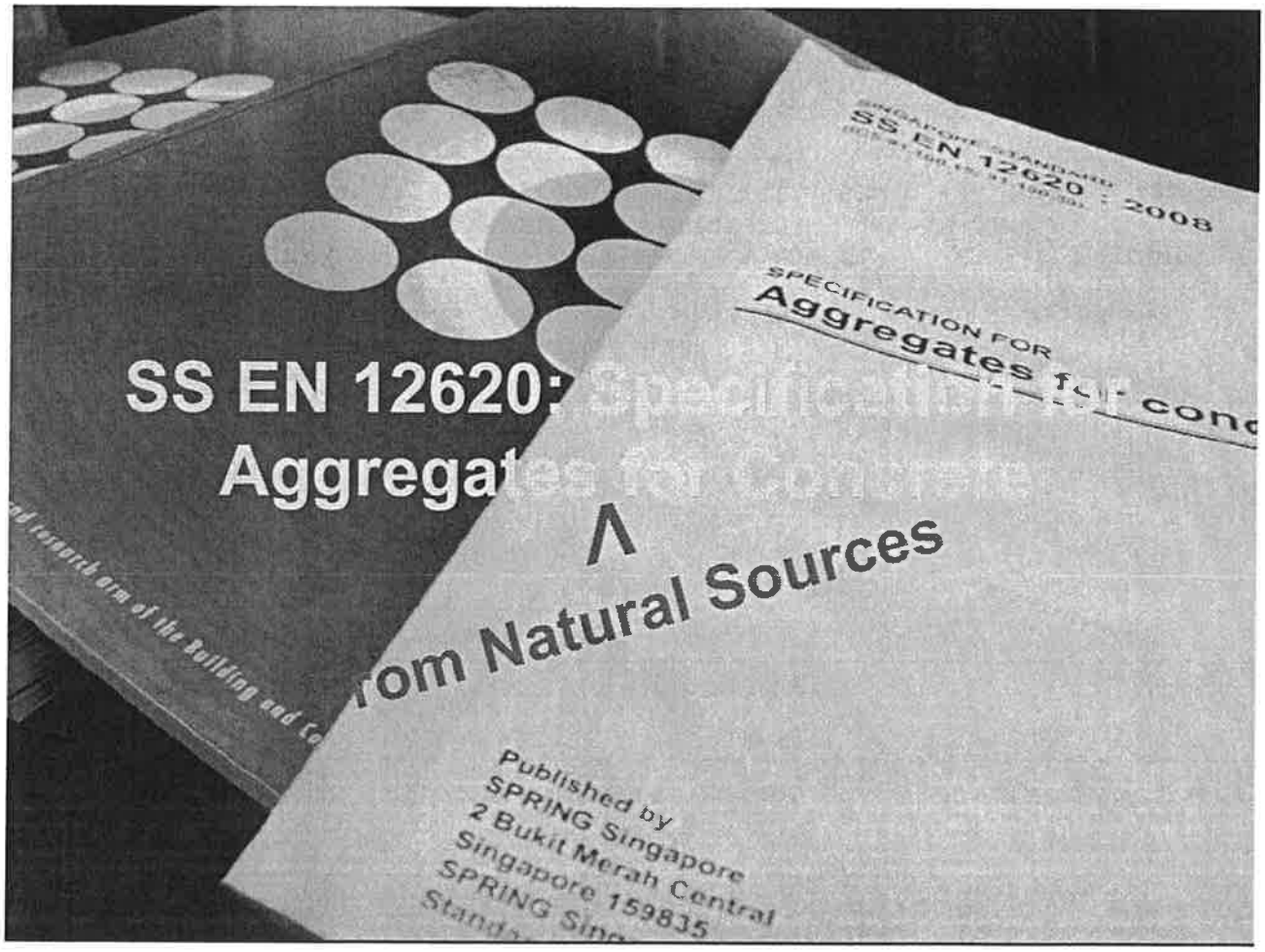
- Performance-based* specs and stds like BS EN standards.
- BCA worked with industry to introduce SS EN 12620- allows the use of recycled & manufactured aggs





SS EN 12620

- "This European Standard specifies the properties of aggs and filler aggs obtained by processing natural, manufactured or recycled materials and mixtures of these aggs for use in concrete. It covers aggs having an oven dried particle density >2 000 kg/m3 for all concrete, including concrete in conformity with EN 206-1 and concrete used in roads and other pavements and for use in precast concrete products. It also covers recycled aggs with densities between 1500 to 2000 kg/m3 with appropriate caveats..."
- It also specifies that a quality control system is in place for use in factory production control and it provides for the evaluation of conformity of the products to this European Standard..."

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Table ZA.1a – Scope and relevant requirement clauses

Product: Aggregates obtained by processing natural, manufactured or recycled materials and mixtures of these aggregates as covered by the scope of this standard **Intended use(s):** Preparation of concrete for use in buildings, roads and other civil engineering works			
Essential Characteristics	**Requirement clauses in this and/or another standard(s)**	**Level(s) and/or class(es):**	**Notes**
Particle shape, size and density	4.2 Aggregate size	None	Designation (*d/D*)
	4.3 Grading	None	Tolerance/ category
	4.4 Shape of coarse aggregate	None	Category
	5.5 Particle density and water absorption	None	Declared value
Cleanliness	4.5 Shell content of coarse aggregate	None	Category
	4.6 Fines	None	Category
Resistance to fragmentation/crushing	5.2 Resistance to fragmentation of coarse aggregate	None	Category

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Table ZA.1a – Scope and relevant requirement clauses *(continued)*

Product: Aggregates obtained by processing natural, manufactured or recycled materials and mixtures of these aggregates as covered by the scope of this standard **Intended use(s):** Preparation of concrete for use in buildings, roads and other civil engineering works			
Essential Characteristics	**Requirement clauses in this and/or another standard(s)**	**Level(s) and/or class(es):**	**Notes**
Resistance to polishing/abrasion/wear	5.3 Resistance to wear of coarse aggregate	None	Category
	5.4.1 Resistance to polishing	None	Category
	5.4.2 Resistance to surface abrasion	None	Category
	5.4.3 Resistance to abrasion from studded tyres	None	Category
Composition/content 5.8 Constituents of coarse recycled aggregates	6.2 Chlorides	None	Declared value
	6.3.1 Acid soluble sulfates	None	Category
	6.3.2 Total sulfur	None	Pass/fail threshold value
	6.3.3 Water-soluble sulfate content of recycled aggs		
	6.4.1 Constituents which alter the rate of setting and hardening of concrete	None	Pass/fail threshold value
	6.5 Carbonate content of fine aggregate for concrete pavement surface courses	None	Declared value

Volume stability	5.7.2 Volume stability - drying shrinkage	None	Pass/fail threshold value
	6.4.2 Constituents which affect the volume stability of air-cooled blastfurnace slag	None	Pass/fail threshold value
Water absorption	5.5 Particle density and water absorption	None	Declared value
Dangerous substances: Emission of radioactivity (for aggregates from radioactive sources intended for use in concrete in buildings) Release of heavy metals Release of polyaromatic carbons Release of other dangerous substances	NOTE in ZA.1 above H.3.3 Knowledge of the raw material H.4 Management of the production	None	Third paragraph of ZA.3
Durability against freeze-thaw	5.7.1 Freeze/thaw resistance of coarse aggregate	None	Categories
Durability against alkali-silica reactivity	5.7.3 Alkali-silica reactivity	None	Declared value

Table ZA 1b – Scope and relevant requirement clauses

Product: Fillers obtained by processing natural, manufactured or recycled materials and mixtures of these aggregates **Intended use(s):** Preparation of concrete for use in buildings, roads and other civil engineering works			
Essential Characteristics	**Requirement clauses in this and/or another standard(s)**	**Level(s) and/or class(es):**	**Notes**
Fineness/particle size and density	4.3.6 Filler aggregate	None	Pass/fail threshold value
	5 5 Particle density and water absorption	None	Declared value
Composition/content	6.2 Chlorides 6.3.1 Acid soluble sulfate 6.3.2 Total sulfur	None None None	Declared value Categories Pass/fail threshold value
	6.4.1 Constituents which alter the rate of setting and hardening of concrete	None	Pass/fail threshold value
Cleanliness	4.6 Fines	None	Category
Volume stability	5.7.2 Volume stability - drying shrinkage	None	Pass/fail threshold value
	6.4.2 Constituents which affect the volume stability of air-cooled blastfurnace slag	None	Declared value
Release of other dangerous substances	NOTE in ZA.1 above H.3.3 Knowledge of the raw material H.4 Management of the production		Third paragraph of ZA.3
Durability against freeze-thaw	5.7.1 Freeze/thaw resistance of coarse aggregate	None	Category

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Table H.3 — Minimum test frequencies for properties appropriate to aggregates from particular sources [a]

	Property	Clause	Notes/ references	Test method	Minimum test frequency
1	Shell content	4.5	Coarse aggregates of marine origin	EN 933-7	1 per year
2	Volume stability - Drying shrinkage	5.7.2		EN 1367-4	1 per 5 years
3	Chloride content	6.2	Aggregates of marine origin	EN 1744-1:1998, Clause 7	1 per week
			Recycled aggregates	EN 1744-5	2 per year
4	Sulfur containing compounds	6.3	Blastfurnace slag and recycled aggregates	EN 1744-1:1998, Clause 12	2 per year
			Aggregates other than air-cooled blastfurnace slag and recycled aggregates	EN 1744-1:1998, Clause 12	1 per year

5	Organic substances: - humus content - fulvo acid (when indicated humus content is high) - comparative strength test - stiffening time - lightweight organic contaminators	6.4.1		EN 1744-1:1998, 15.1 EN 1744-1:1998, 15.2 EN 1744-1:1998, 15.3 EN 1744-1:1998, 14.2	1 per year 1 per year 1 per year 2 per year
6	Dicalcium silicate disintegration	6.4.2.1	Blastfurnace slag only	EN 1744-1:1998, 19.1	2 per year
7	Iron disintegration	6.4.2.2	Blastfurnace slag only	EN 1744-1:1998, 19.2	2 per year
8	Influence on initial setting time of cement	6.4.1	Recycled aggregates only	EN 1744-6	2 per year
9	Constituents of coarse recycled aggregates	5.8	Coarse recycled aggregates only	prEN 933-11	1 per month
10	Particle density and water absorption	5.5	Coarse recycled aggregates only	EN 1097-6	1 per month
11	Water-soluble sulfate	6.3	Recycled aggregates only	EN 1744-1	1 per month

[a] For recycled aggregates, the source can be considered as the processing depot.

European Standards and Recommendations

Countries	Density	Composition	Replacement of Fine Aggregates	Replacement of Coarse Aggregates
Belgium	+	+	Allowed with restrictions	Up to 100%
Denmark	+	+	Limited to 20%	Up to 100%
Germany	+	+	Not allowed	Up to 45%
Netherlands	+	+	Limited to 20%	Up to 20%
Switzerland	-	+	Allowed	Dependant on applications
United Kingdom	-	+	Not allowed	Up to 20%

Road Usage

- LTA Specs- "MATERIALS & WORKMANSHIP SPECIFICATION FOR CIVIL & STRUCTURAL WORKS"
- "...All aggregates for use in concrete shall comply with SS 31. Aggregates used shall not be alkali reactive..."
- SS 31- *Specification for aggregates from natural sources for concrete*

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SUB-BASE

- "...Sub-base material shall be natural sand, crushed rock or crushed concrete or any other granular material accepted by the Engineer..."
- "...Milled waste, which is asphaltic concrete machine-milled from existing road, could be used as sub-base material subject to Engineer's approval..."

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ROAD BASE

- "...The base aggregate shall consist of graded crushed, clean and hard angular aggregate complying with the requirements of SS 31..."

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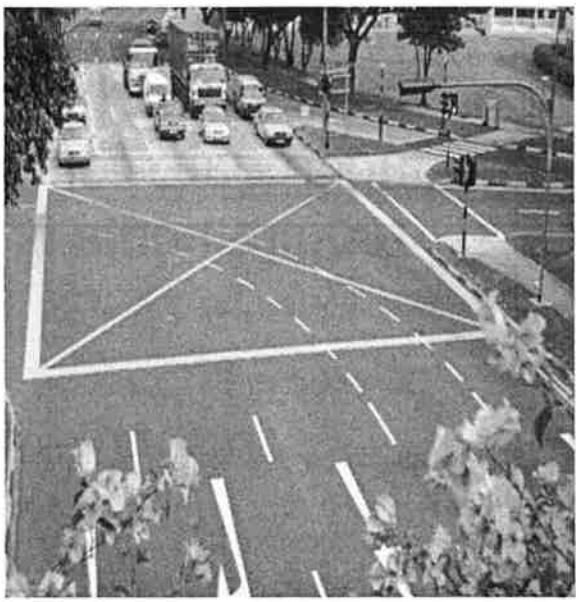
ASPHALTIC CONCRETE

- "...Aggregates shall consist of crushed stone, crushed gravel or crushed slag with or without sand or other inert finely divided mineral aggregate..."
- "...tested in accordance with *ASTM C131..." "...#ASTM D4791..."

ASPHALTIC CONCRETE

"...Slag used as coarse agg shall be air-cooled blast-furnace slag and shall have a compacted weight of not less than 1.12 tonnes/m^3 when tested in accordance with *ASTM C29..."



Use of RCA for Road Construction in Other Countries

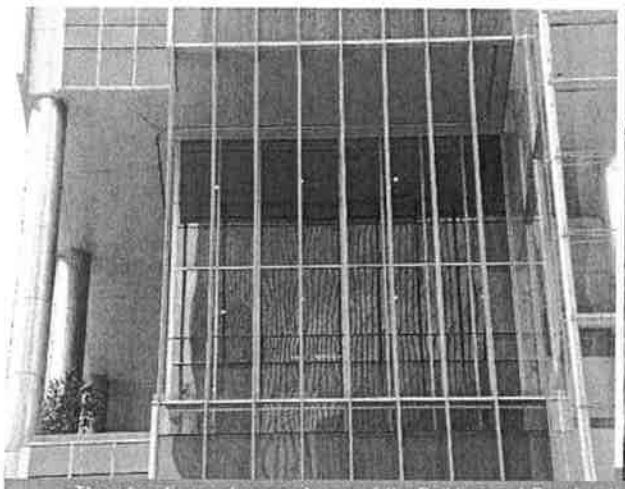
- **Survey by the Organization for Economic Co-operation and Development (OECD, 1995)**

	AUT	BEL	CAN	JPN	NL	UK
% Recycled	80	100	90	70	100	75

- **RCA has been widely used in the base course**

Building Components Usage

- Prefab non-concrete components
- Eg. Glass facades, claddings





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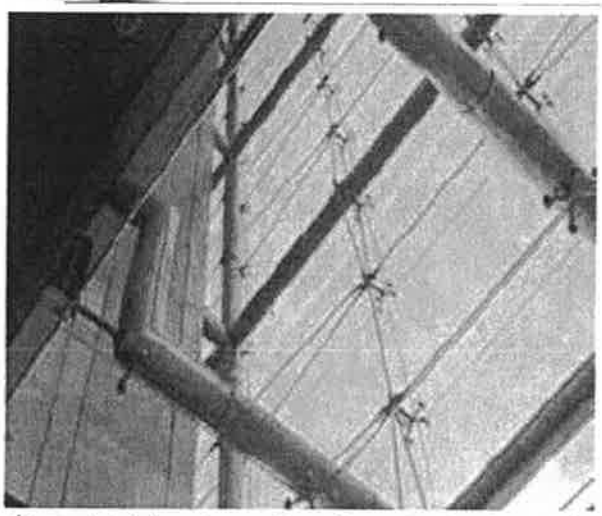
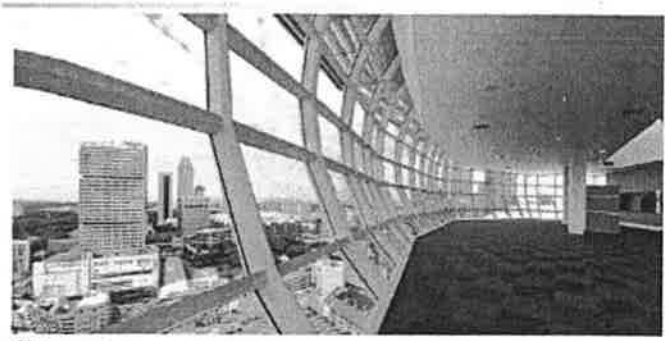


4-legged stainless steel spider within a tension truss point supported glass walls



National Library



Novena Square

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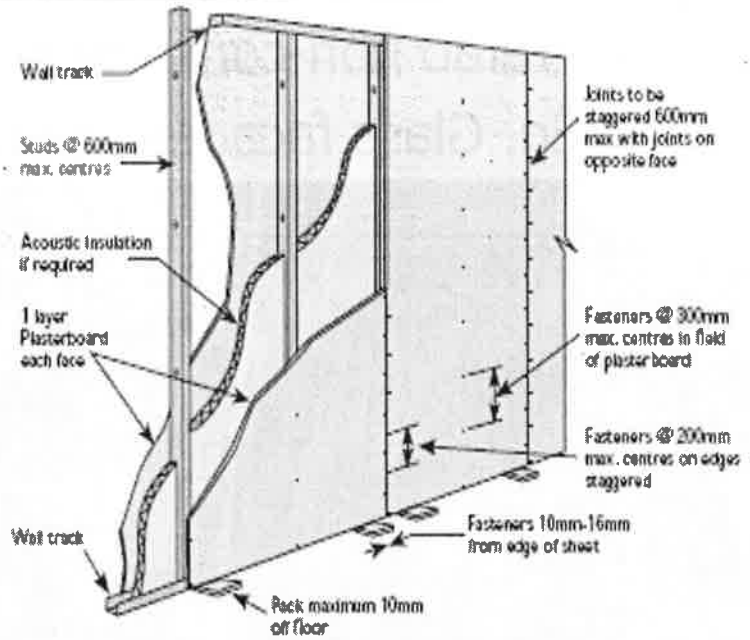
Dry Internal Partition Walls

- Use of plasterboards or fiber cement boards as internal walls
- Improvement in performance=> acoustic insulation, thermal Insulation, fire resistance



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Private Residential Project



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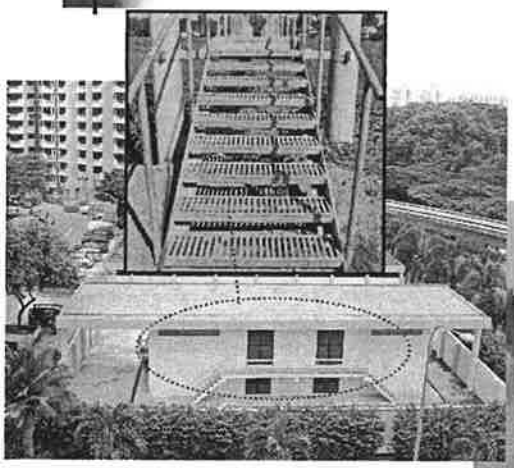
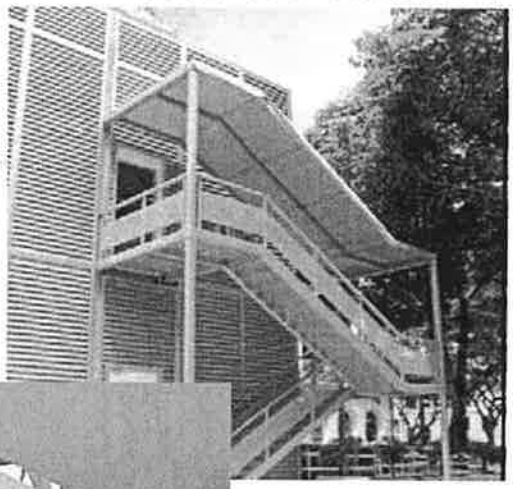
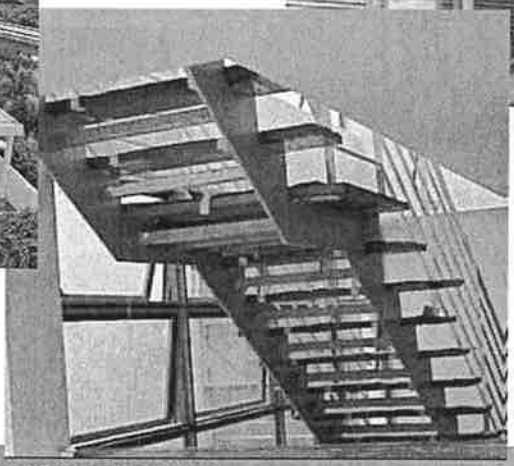
Prefab Staircases



Electric Sub-station





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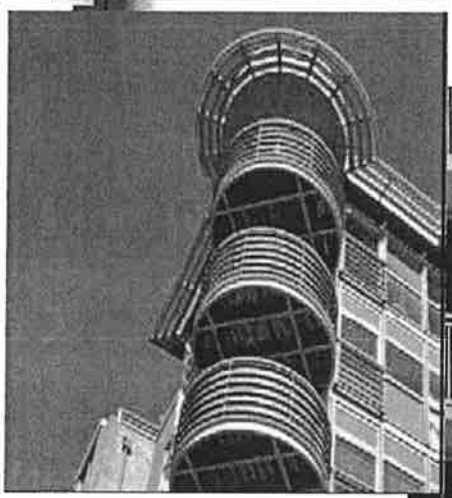
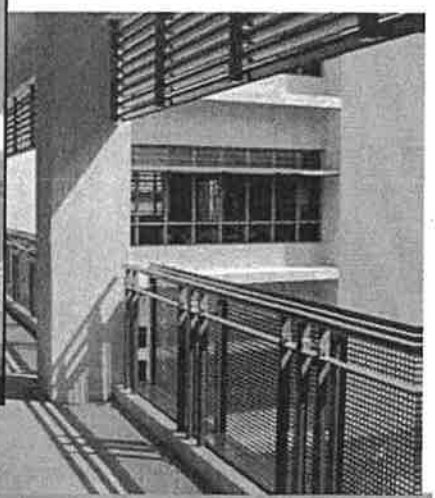
Parapets & Railings







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Prefab Roofs



Changi Airport Terminal 2

Supreme Court of Singapore



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HDB Lift Upgrading

- Ferroconcrete lift shafts - Use of 50mm thin wall
- Steel lift shafts







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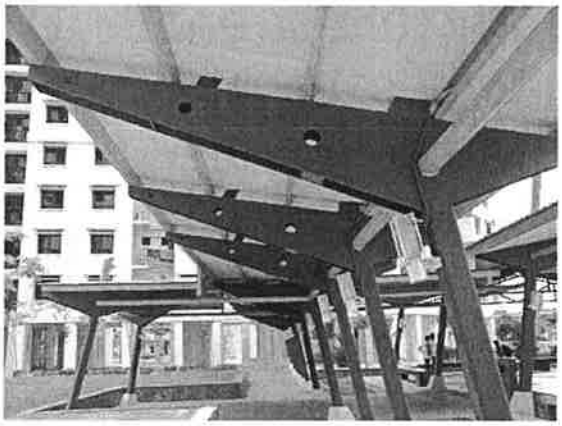
Precinct structures





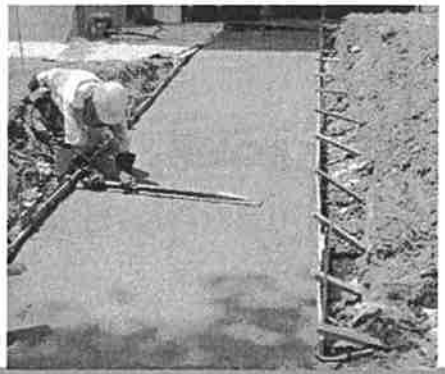
Light steel structure and metal roof for linkways, drop-off porches etc

Concrete for Non-Structural Usage

- Eco-concrete
  - Min. 50% of total aggregate content- recycled material (Cu slag, RCA)

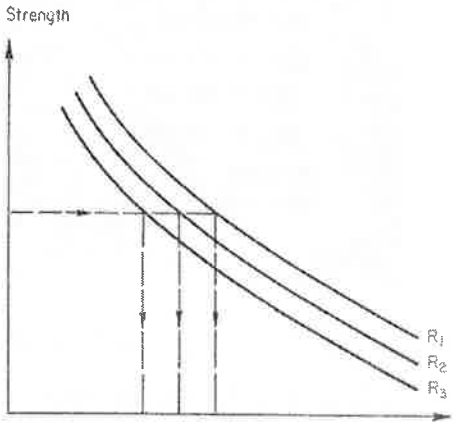






Technical Considerations

- Concrete strength- Design modifications- eg. adjustment of W/C
- Concrete durability- generally determined by the cement type, cement content & W/C- increase "cement" content, reduce W/C



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BCA Green Mark V4.1

BCA GREEN MARK

5 Key Assessment Criteria

1. ENERGY EFFICIENCY
2. WATER EFFICIENCY
3. ENVIRONMENTAL PROTECTION
4. INDOOR ENV. QUALITY

Gold^{Plus} Rating: Achieve ≥ 3 points

Platinum Rating: Achieve ≥ 5 points

Building and Construction Authority

BCA Green Mark V4.1

Green Mark Version 4 - Non Residential Buildings

Proposed: Points Allocation - Part 3

(II) Other Green Requirements	Version 3.0	Version 4.0
Part 3 : Environmental Protection		
3-1 Sustainable Construction	14	10
3-2 Sustainable Materials	...	8
3-3 Greenery	6	8
3-4 Environmental Management Practice	8	7
3-5 Public Transport Accessibility	2	2
3-6 Refrigerants	2	2
3-7 Stormwater Management	...	3



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Scoring System

Encourage recycling and the adoption of building designs, construction practices and materials that are environmentally friendly and sustainable

(a) Use of Sustainable and Recycled Materials

(i) Green Cements with approved industrial by-product (such as Ground Granulated Blastfurnace Slag (GGBS), silica fume, fly ash) to replace Ordinary Portland Cement (OPC) by at least 10% by mass for superstructural works.

1 point

(ii) Recycled Concrete Aggregates (RCA) and Washed Copper Slag (WCS) from approved sources to replace coarse and fine aggregates for concrete production of main building elements.

Extent of Coverage : The total quantity used (in tonnage) for replacement of coarse or fine aggregates must not be less than the minimum usage requirement that is [0.03 x Gross Floor Area (GFA in m^2)]

Note (7) : For structural building elements, the use of RCA and WCS shall be limited to maximum 10% replacement by mass of coarse/fine aggregates respectively or as approved by the relevant authorities.

Quantity of RCA / WCS	Points allocation
≥ 0.5 times (0.5X) minimum usage requirement	1 point
≥ 1 X minimum usage requirement	2 points
≥ 1.5 X minimum usage requirement	3 points
≥ 2 X minimum usage requirements	4 points

(Up to 5 points for (a)(i) and (a)(ii))



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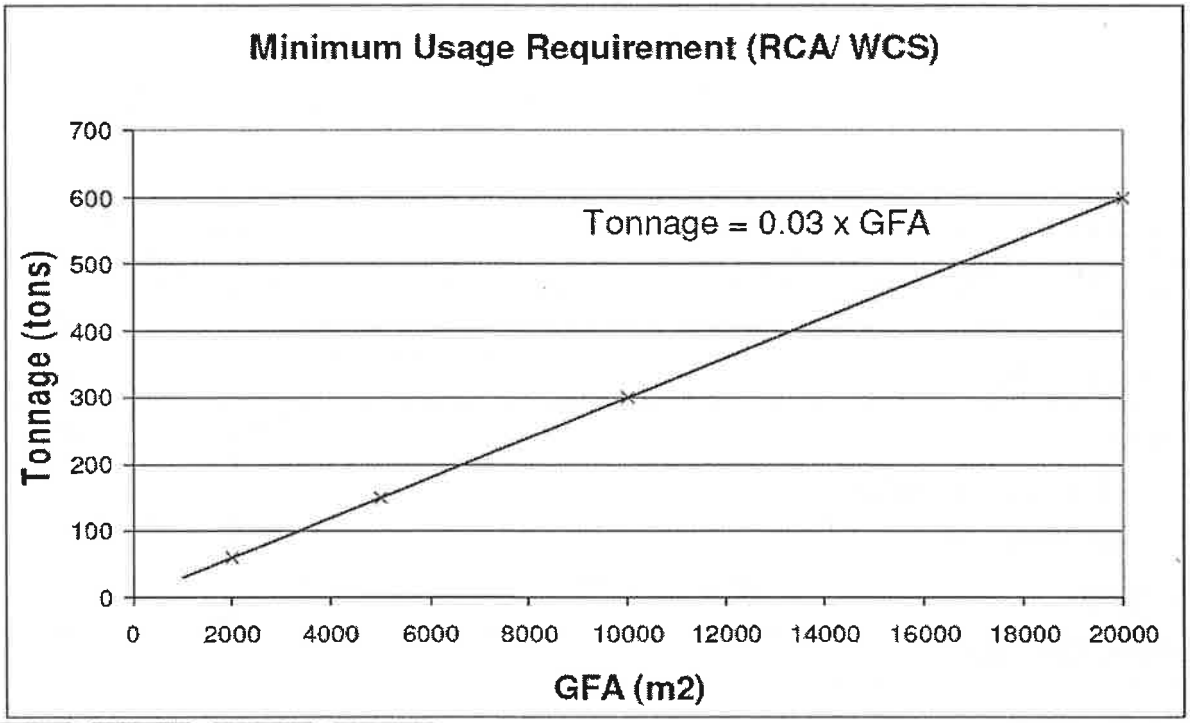
Proposed Usage Limits





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Scoring System

Documentary Evidence

- ✓Extract of tender specs showing requirements to use green cements, RCA or WCS
- ✓Evidence of site delivery of these materials



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Scoring System

3-2 Sustainable Products	Weightage based on the extent of environmental friendliness of products			Points scored based on the weightage and the extent of coverage & impact
Promote use of environmentally friendly products that are certified by approved local certification body and are applicable to non-structural and architectural related building components.	Good	Very Good	Excellent	1 point for high impact item 0.5 point for low impact item (Up to 8 points)
Determined by approved local CBs subject to BCA's evaluation	1	1.5	2	



Building and Construction Authority

Scoring System

High Impact

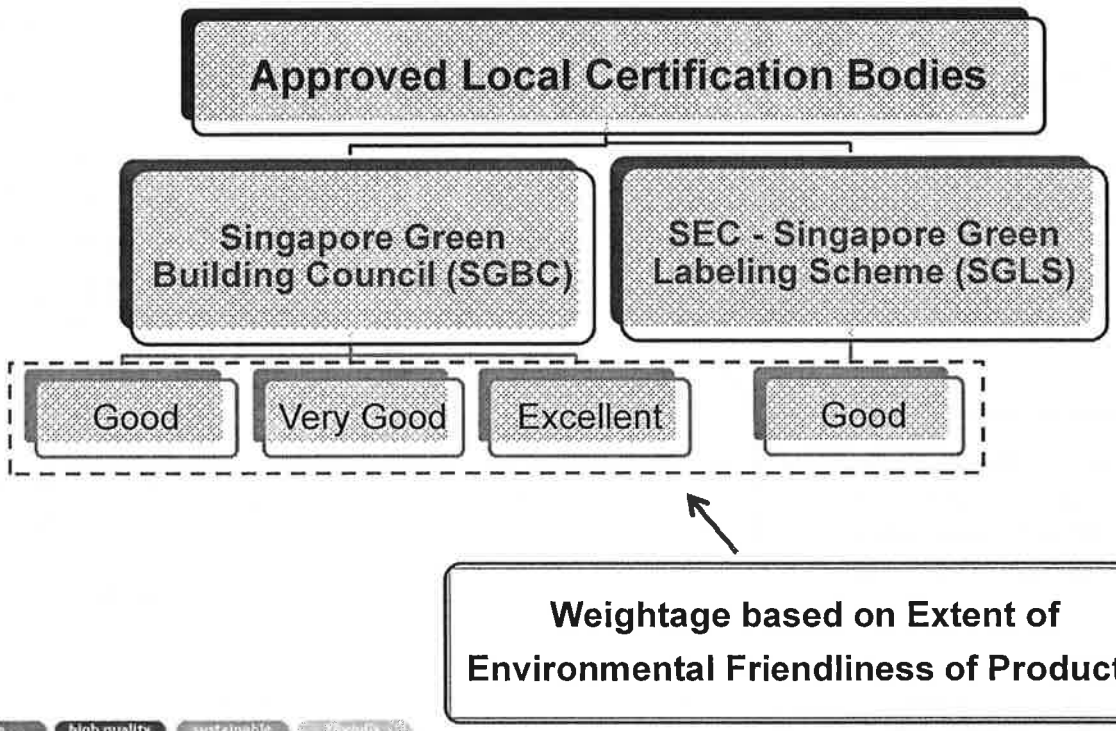
✓Products used in dwelling units; used for main building elements/ functional spaces with extent of coverage >50%

Low Impact

✓Extent of coverage <50%

✓Used for common areas or external works







Weightage based on Extent of Environmental Friendliness of Products

1. Singapore Green Building Council (SGBC)
-- focuses on building products

Score (Based on SGBC methodology)		
50-60%.....	✓	Good
61-75%.....	✓✓	Very Good
76-85%.....	✓✓✓	Excellent
85% & above...	✓✓✓✓	Leader

Weightage based on the Extent of Environmental Friendliness of products		
Good	*Very Good*	*Excellent*
0.5	1.5	2.0



Note:- Scale may vary with specific to product categories

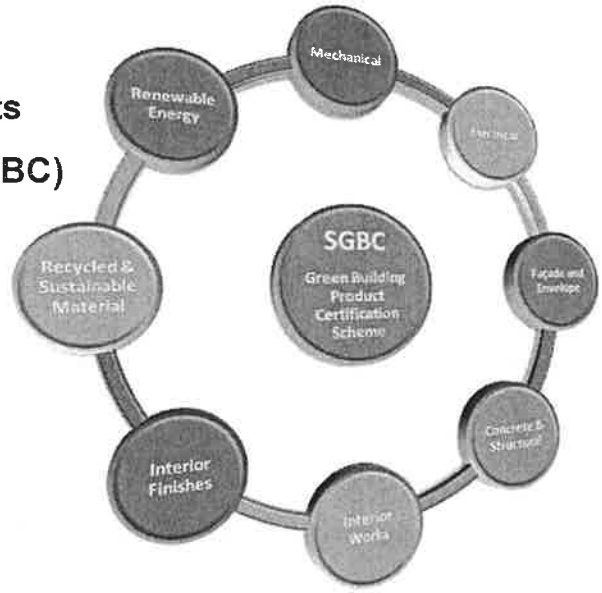


Weightage based on Extent of Environmental Friendliness of Products

Singapore Green Building Council (SGBC)

8 Building product groups:

1. Mechanical
2. Electrical
3. Façade & Envelope
4. Concrete & Structure
5. Interior Works
6. Interior Finishes
7. Recycled Materials
8. Renewable Energy



Product listing:

http://www.sgbc.sg/index.php/listing/products/



SGBC Certified Products - Example

Example of a proposed development with the following provisions:

(a) Use of carpets for all office spaces. Product is not certified.

(b) Use of panel boards as internal partitions for more than 50% of the office spaces and the product is rated to be 'Very Good' by the approved certification body.

(c) Precast concrete road kerbs. Product is rated as 'Good' by approved local certification body.

(d) Use of roof waterproofing coating. Product is rated as 'Very Good' by approved local certification body.

(e) Use of wooden doors for all areas. Product is rated as 'Excellent' by approved local certification body.

Products and Extent of coverage		With approved certification	Points allocated based on impact (A)	Weightage based on rating (B)	Points scored (AxB)
(a)	Carpets for all office spaces	No	1	NA	0
(b)	Panel boards as internal partition for more than 50% of office spaces	Yes	1	1.5	1.5
(c)	Precast road kerbs	Yes	0.5	1	0.5
(d)	Roof waterproofing	Yes	0.5	1.5	0.75
(e)	Wooden doors for all areas	Yes	1	2	2

Therefore, points scored for 3-2 (ii) = 1.5 +0.5+0.75+2 = 4.75 points



Weightage based on Extent of Environmental Friendliness of Products

Weightage based on the Extent of Environmental Friendliness of products		
Good	*Very Good*	*Excellent*
0.5	1.5	2.0

2. SEC –
Singapore Green Labeling Scheme (SGLS)

❖Weightage of **all** SGLS certified products
→ 'Good'

❖Product listing:
http://www.sec.org.sg/images/sec_document/green_label_products.xls



SGLS Certified Products - Example

Example of a proposed development using the following products that are rated as 'Good' by the approved local certification body.

Products and Extent of coverage		With approved certification	Points allocated based on impact	Weightage based on rating	Points scored
(a)	Carpets for all office spaces	Yes	1	0.5	0.5
(b)	Panel boards as internal partition for more than 50% of office spaces	Yes	1	0.5	0.5
(c)	Precast concrete road kerbs	Yes	0.5	0.5	0.25



Part 5 – Other Green Features	Green Mark Points
RB 5-1 Green Features and Innovations Encourage the use of other green features which are innovative and have positive environmental impact. Examples : ▪ Pneumatic waste collection system ▪ Carbon footprint of development ▪ Concrete Usage Index of development ▪ Dual chute system ▪ Self cleaning façade system ▪ Conservation of existing building structure ▪ Water efficient washing machines with Good rating and above. ▪ etc	2 points for high impact item 1 point for medium impact item 0.5 point for low impact item (Up to 7 points)



Part 5 – Other Green Features	Green Mark Points
NRB 5-1 Green Features and Innovations Encourage the use of other green features which are innovative and/or have positive environmental impact. Examples : ▪ Pneumatic waste collection system ▪ Carbon footprint of development ▪ Concrete Usage Index of development ▪ Dual chute system ▪ Self cleaning façade system ▪ Conservation of existing building structure ▪ etc	2 points for high impact item 1 point for medium impact item 0.5 point for low impact item (Up to 7 points)



Building and Construction Authority

Carbon Footprint – Objective & Requirement

OBJECTIVE

To calculate the carbon emissions resulted from the associated energy used during construction and operational phase of a development.

REQUIREMENT

❖To produce a complete carbon footprinting report of the development **EITHER** by appointing an independent carbon consultant, **OR** by completing a carbon footprinting form provided by BCA.

❖A simple carbon footprinting form has been developed jointly by BCA-NUS to capture the overall energy used from the construction and building operation phase of a development.



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

ENERGY USAGE OF MATERIALS PRODUCTION AND ON-SITE CONSTRUCTION

Project Title: _____

Project GFA: _____

Section A: Materials Production											
Material	Total Energy usage per month										
	Electricity		Diesel		Petrol		Gas		Others (Pls Specify)		
	kWh	$/kWh	Litres	$/litres	Litres	$/litres	KG	$/KG	Fuel	Units	$/unit
Cement											
Sand											
Concrete											
Aggregate											
Brick											
Steel											
Aluminum											
Glass											
Paint											
Tiles: Ceramic											
Tiles: Granite											

Section B1: Material Usage (On-Site)	
Material	Total Quantity Used
Cement	
Sand	
Concrete	
Aggregate	
Brick	
Steel	
Aluminum	
Glass	
Paint	
Tiles: Ceramic	
Tiles: Granite	

Section B2: Energy Usage (On-Site)		
	Units used	$/unit
Electricity (kWh and $)		
Diesel (litres and $)		
Petrol (litres and $)		
Gas (KG and $)		
Coal (ton)		
Crude Oil (KL)		

Section C: Operational Carbon (Post-Occupancy)		
	Units used	$/unit
Electricity (kWh and $)		
Renewable Energy Sources		

Carbon Footprint – Point Allocations

1 POINT will be awarded for submission of:-

❖COMPLETE carbon footprinting REPORT which include embodied and operational carbon emissions of the project development, done by an independent and registered carbon consultant.

OR

❖COMPLETE carbon footprinting FORM (consist of 11 top common materials used in a typical project) appended in the BCA Green Mark Certification Standard for New Buildings (GMV4.0).

0.5 POINT will be awarded for:-

❖PARTIAL submission of at least 4 out of 11 materials data required in the carbon footprinting form.



Building and Construction Authority

Carbon Footprint – Necessary Information & Documentation

Information Required	Source of Information
Energy used for the material production	Material suppliers
Quantity of materials used for construction	Bill of Quantities
Energy used on construction site	Contractor's book-keeping
Estimates on energy used on building operation phase	EEI value

NOTE:-

❖ Consultants will need to liaise closely with materials suppliers

AND

❖ Contractors to obtain the relevant data required in the carbon footprinting form
(e.g. Energy involved in cement production, quantity of cement used in the project)



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Other Relevant Info…

5.1 Other Green Features

- ✓Use of precast toilets:
  - ➢**2 pts** for >75% of all toilets
  - ➢**1 pt** for >50% of all toilets
  - ➢**0.5** pt for ≥25% of all toilets
- ✓Adoption of demolition protocol to maximise resource recovery of demolition materials for reuse/ recycling



Building and Construction Authority

Other Relevant Info…

Demolition Protocol (Incorporated into SS 557)

- ➢**2 pts** for recovery rate of >35% crushed concrete waste sent to approved recyclers with proper facilities
- ➢**1 pt** for recovery rate ≥20% crushed concrete waste sent to approved recyclers with proper facilities



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Other Relevant Info…

- ✓*Workshop on SC- "Material Recycling for Sustainable Construction"
- ✓For worked egs, pls download:
  - ➢*http://www.bca.gov.sg/EnvSusLegislation/others/Env_Sus_Code2013.pdf*



BCA GREEN MARK

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THANK YOU