ISBN: 978-84-697-1815-5

Sustainable construction: Singapore's journey towards zero landfill

Speakers:
Neng, Jeffery Kwei Sung[1]; Low, Giau Leong[2]; Bek, June Jun Hui[3]

[1] Building & Construction Authority (BCA), Singapore
[2] Building & Construction Authority (BCA), Singapore
[3] Building & Construction Authority (BCA), Singapore

Abstract: *With a land area of 716 km^2 housing a population of 5.31 million, Singapore is a resource-challenged city-state with limited land and natural resources. It is hence critical for us to focus on sustainable development. With this as the backdrop, the Sustainable Singapore Blueprint was launched in 2009 to address these challenges.*

Sustainable Construction (SC) has a big part to play, given the amount of natural resources the building sector consumes. As the regulatory authority of the built environment, the Building & Construction Authority (BCA), plays a leading role, working with our stakeholders to champion SC's policies and best practices. The paper outlines a number of key initiatives to drive SC adoption to meet our long term objective towards zero landfill for the building sector.

Keywords: resources, sustainable construction, policies, best practices, zero landfill

Introduction

As a resource-challenged city-state, Singapore understands the need to use resources efficiently. For this reason, the Inter-Ministerial Committee on Sustainable Development (IMCSD) launched the Sustainable Singapore Blueprint in 2009 with resource efficiency as one of its key objectives.

The building sector consumes a significant amount of natural resources as well as generates considerable wastes from construction and demolition activities each year. Concrete waste which constitutes the bulk of the 1.0 to 1.5 million tons of construction and demolition (C&D) waste generated annually can be potentially converted to higher-value materials for various building and construction works. Other waste streams include copper slag with about 0.2 to 0.4 million tons generated annually.

As Singapore's regulatory authority of the built environment, Building & Construction Authority (BCA) has a leading role to play. BCA adopts a life-cycle approach that looks at the efficient use of building materials at the design stage of the development, secures a higher quality of materials salvaged at the demolition stage, promotes closed-loop recycling of building materials and regulates waste flow to our landfill.

To this end, BCA worked with various stakeholders of the sustainable construction (SC) value chain to develop and roll out the following schemes.

ISBN: 978-84-697-1815-5

Schemes to Support SC

These include incentives such as the Sustainable Construction Capability Development Fund (SC Fund), the SC Score under BCA's Green Mark (GM) Scheme, up-cycling initiative and demolition protocol.

The Sustainable Construction Capability Development Fund (SC Fund)

The $15 million SC Fund was set up in 2010 to build up capabilities in recycling of C&D waste and to encourage industry stakeholders in adopting SC materials, practices and technologies for construction, with the eventual aim to steer the industry towards self-sustenance in the demand and supply of SC materials.

BCA's Green Mark (GM) Scheme

This is a green building rating tool launched in 2005 to drive Singapore's construction industry towards more environment-friendly buildings. It is a key supporting lever to promote the adoption of SC initiatives. Developers applying for higher-tiered awards (Gold^{Plus} and Platinum awards) are required to achieve certain SC proficiency levels, either through using recycled materials or through well-thought-out designs to use concrete efficiently in their building projects, or both.

Up-cycling Initiative

In order to conserve precious natural resources such as granite for structural building works, BCA started an up-cycling initiative to channel the concrete waste usage from lower-value applications such as road works to building works. It involves processing concrete waste into recycled concrete aggregates (RCA) to replace granite aggregates in structural concrete used for building works. At the same time, BCA is also exploring the potential use of alternative waste materials to replace concrete waste for lower-value and other civil engineering applications.

Demolition Protocol

This is a set of procedures to help contractors better plan their demolition process to maximise recovery of potential wastes for reuse and recycling, thus diverting wastes going to the landfill. The procedures consist of three main components, namely (1) pre-demolition audit to identify potential materials to be recovered, (2) sequential demolition for recovery of better quality demolition waste, and lastly (3) on-site sorting where the contractors follow a waste management schedule that complies with requirements of relevant authorities for sorting, processing, recovery and disposal of demolished materials.

ISBN: 978-84-697-1815-5

The protocol is now being incorporated as part of a Singapore Standard, SS 557 developed by BCA in collaboration with SPRING in 2010.

Public-Private Partnership

Our journey towards zero landfill requires concerted effort from both the public and private sector. With the SC policies and initiatives in place, BCA collaborated with industry stakeholders to push the boundaries of recycling and up-cycling of concrete waste by using these materials for structural applications in actual building projects.

Samwoh Eco-Green Building

Samwoh Eco-Green Building is the first building in the region to use up to 100% RCA in structural concrete works. It has effectively demonstrated the feasibility of using high percentage of RCA in structural concrete and further boosts the confidence of the industry in using recycled materials for building works.

Tampines Concourse

The extensive use of recycled materials in Tampines Concourse exemplified green building construction. 10% washed copper slag (WCS) and 20% ground granulated blast furnace slag (GGBS) were used for primary structures including all the columns, walls and beams; while 30% WCS, 20% GGBS and 20% recycled aggregates were used for non-structural components such as apron drains and footpaths.

GAIA Condominium

GAIA condominium is the first high-rise residential development to adopt recycled materials in structural concrete elements. 20% RCA, 10% GGBS and 10% WCS were used for the primary structures. This project reinforced the feasibility of using recycled materials in structural applications and further encouraged replication in other residential projects.

The successful implementation of these demonstration projects resulted in the revision of our building codes to expand the use of RCA in structural concrete from 10% to 20% (Higher dosages would be considered on a case-by-case basis). Likewise for WCS, up to 10% is allowed for use in structural concrete with higher dosages considered case-by-case.

From Recycling To Focus On Design

Thus far, the industry stakeholders and professionals have responded very positively to the downstream recycling efforts in the building's life-cycle. However, upstream efforts which

ISBN: 978-84-697-1815-5

emphasize on the design stage of the life-cycle are still rather lacking. It is thus essential to educate the industry and raise awareness on the importance of adopting a green mindset for building developments – To design with 'Green' intent. Normally when a building is designed more efficiently, better sustainability indicators such as lower Concrete Usage Index (CUI) values can be achieved without compromising on construction safety and productivity. This would be explained in greater detail in the following paragraphs.

Concrete Usage Index (CUI)

To measure the use of concrete in building projects BCA worked with the industry and other stakeholders to formulate an index unique only to Singapore, known as the CUI. The index is defined by the volume of concrete needed to cast a square metre of constructed floor area or CFA (m^3/m^2), for superstructures including both structural and non-structural elements.

CUI allows consultants to compare the amount of concrete used for various design options. Consultants will be able to achieve greater resource efficiency by fine-tuning their building designs. For instance if a typical development has a CUI of 0.6, by reducing it to 0.5 by means of designing for less concrete partition walls, about 16% concrete savings can be achieved already for every square metre of constructed floor area. Reduced concrete translates to lesser natural aggregates used for construction and also lesser demolition/ concrete waste generated at the end of the building's service life.

To further recognise building owners' green efforts, an additional bonus point will be awarded to the overall GM score for disclosing the CUI of their new development.

The following two GM Platinum projects will illustrate how sustainability is achieved when buildings are designed with 'Green' intent.

ITE College West

The 9.54ha 'ITE College West' campus achieved a good CUI of 0.42. A combination of precast hollow-core slabs and pre-stressed flat slabs construction were adopted instead of a beam-slab structural system. The absence of beams also allowed for the design of lower storey heights resulting in a significant reduction of concrete as well as steel usage.

Hundred Trees Condominium

ISBN: 978-84-697-1815-5

The 396-unit private residential development 'Hundred Trees Condominium' achieves a good CUI of 0.42. This is made possible through the use of Cobiax[1] system which contributed to a reduction of about 800m^3 of concrete.

Appropriate design tools to facilitate the computation and design of low-CUI buildings are critical and essential in order to encourage industry adoption. BIM has been identified as the game-changing technology to improve productivity and also promote a greater level of integration across various disciplines over the entire construction value chain.

Riding On BIM Wave

In November 2010, BCA formulated a BIM Roadmap and set a target to have 80% of the construction industry use BIM for planning and design by end 2015. To encourage more stakeholders to consciously keep track of the concrete usage in building developments, BCA is working with potential software developers and the industry to develop add-on tools on BIM platforms to obtain CUI values automatically from the BIM models. This will replace manual CUI calculation which would otherwise take 1 week or more.

Conclusion

SC is critical in helping Singapore conserve and use limited natural resources effciently. As the regulatory authority for the building sector, BCA plays the leading role to drive the adoption of SC practices by using the life-cycle approach, with a focus on Recycling / Use of recycled materials and sustainability-focused design approach for buildings.

Our downstream recycling efforts have started to make an impact on the landfill by channelling construction waste away from it to higher-value applications such as structural concrete for building works. But more importantly, we will need to institutionalise the concept of 'design with 'Green' intent' targeting at upstream efforts so as to achieve greater resource efficiency.

With the SC policies and initiatives now in place, BCA is confident that the building sector will embark on this journey to achieve sustainability and help meet our long term objective of zero landfill in time to come.

[1] The Cobiax technology helps to optimise the overall material effi ciency through the positioning of hollow void formers modules within concrete slabs which reduced unnecessary dead load in the concrete slab of the structure. About 25% concrete savings for the floor slabs could be achieved using the Cobiax system.

ISBN: 978-84-697-1815-5

References

1. Ministry of the Environment and Water Resources, and Ministry of National Development. 2009. A Lively and Liveable Singapore: Strategies for Sustainable Growth
2. Centre for Sustainable Building and Construction, BCA. 2012. Sustainable Construction, A Guide on the Use of Recycled Materials, Singapore
3. BCA Sustainable Construction Capability Development Fund, Singapore. Website accessed on 10 June 2013. http://www.bca.gov.sg/Professionals/GovAsst/govasst.html.
4. BCA Green Mark Scheme, Singapore. Website accessed on 10 June 2013. http://www.bca.gov.sg/GreenMark/green_mark_buildings.html.
5. Spring Singapore. 2010. Singapore Standard SS 557 : 2010 (ICS 91.200), Singapore.
6. Samwoh Eco-Green Building, Singapore. Website accessed on 10 June 2013. http://www.samwoh.com.sg/index.php?option=com_content&view=article&id=69.
7. Centre for Sustainable Building and Construction, BCA. 2012. Sustainable Construction; A Guide on Concrete Usage Index, Singapore.