Policy and Strategy in Construction Industry, Singapore Perspective

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Acknowledgement

The speaker would like to sincerely thank the committee on the Civil Engineering Informatics of the Japan Society of Civil Engineers, Japan Construction Information Center (JACIC) and Professor Nobuyoshi Yabuki for providing us generous financial supports creating an opportunity for us to meet and share with our friends from various Asia-Pacific countries, our thought and policy on construction activities.

Substantial information and data on Singapore construction industry obtained from the Singapore Building Control Authority (BCA) and other sources are gratefully acknowledged. These are also cited in the relevant slides where appropriate. However, it is the author’s sole responsibility for any incomplete or inaccurate data included in the presentation.
Topics Covered in this Presentation:

- Safety in Construction Industry
- Productivity in Construction Industry
- Sustainability Development and Green Environment

Up-Down Basement Construction

ArtScience Museum, Marina Bay

Punggol Waterway

Marina Barrage

Sengkang Floating Wetland
Singapore Construction Activities

Garden by the Bay

Singapore Skyline

Construction Activities in Singapore

Esplanade Bridge
### Singapore Construction Output

#### CONSTRUCTION OUTPUT

<table>
<thead>
<tr>
<th>Year</th>
<th>Public Sector</th>
<th>Private Sector</th>
</tr>
</thead>
<tbody>
<tr>
<td>2001</td>
<td>7.17</td>
<td>6.21</td>
</tr>
<tr>
<td>2002</td>
<td>7.05</td>
<td>6.39</td>
</tr>
<tr>
<td>2003</td>
<td>6.39</td>
<td>6.49</td>
</tr>
<tr>
<td>2004</td>
<td>5.29</td>
<td>6.46</td>
</tr>
<tr>
<td>2005</td>
<td>5.16</td>
<td>7.01</td>
</tr>
<tr>
<td>2006</td>
<td>6.01</td>
<td>7.77</td>
</tr>
<tr>
<td>2007</td>
<td>7.60</td>
<td>8.71</td>
</tr>
<tr>
<td>2008</td>
<td>12.36</td>
<td>18.44</td>
</tr>
<tr>
<td>2009</td>
<td>18.44</td>
<td>20.75</td>
</tr>
<tr>
<td>2010</td>
<td>16.37</td>
<td>10.97</td>
</tr>
</tbody>
</table>

Safety in Construction Industry

Besides the SOP stipulating safety measures at sites, the Building and Construction Authority (BCA) has pursued and implemented the following key features in the design and construction of infrastructure in Singapore:

- **The Accredited Checkers System** to enforce an independent assessment of structural design by another team of experienced professional engineers.
- **The Updating of Standards and Codes of Practice** to adopt the state of the art in design and construction of infrastructure.
- **The Licensing of Builders** to ensure that they are professionally competent.
- **The Periodic Structural Inspection (PSI) Program** to spot any defects and early rectifications.
- **Education and Retraining** of Professionals and Workforce. It is mandatory for construction supervisors to attend certain course before becoming registered CoreTrade personnel.
Safety First

CONGRATULATIONS!
NUS Kent Vale Team
For Achieving
2 Million Accident Free Man-Hours
Up-to-Date Structural Design Codes

Singapore construction industry adopts the Singapore Standards (National Annex) prepared by SPRING Singapore based on various Eurocodes on structural design. These include the following:

SS EN 1990 : 2008. to Eurocode 0 – Basis of structural design;
SS EN 1991-1-4 : 2009. to Eurocode 1 – Actions on structures;
SS EN 1995 : XXXX. to Eurocode 5 – Design of timber structures;
SS EN 1996 : XXXX. to Eurocode 6 – Design of masonry structures;
SS EN 1997-1 : 2010. to Eurocode 7 – Geotechnical design;
SS EN 1998 : XXXX. to Eurocode 8 – Design of structures for earthquake resistance;
SS EN 1999 : XXXX. to Eurocode 9 – Design of aluminium structures.
Productivity in Construction Industry

Key features adopted for construction productivity in Singapore are:

(1) **Framework for buildability with less risk, time, material and manpower**, through, e.g., prefabrication system & up-down basement construction for tall buildings.

(2) **Raising the skills and capabilities of the workforce** via training & retraining of the workforce, providing incentives to retain experienced workers and construction registration of tradesmen (CoreTrade).

(3) **Providing Construction Productivity & Capability Fund (CPCF) of $250 million** to promote the following activities:
   (i) Enhanced BCA-Industry Scholarship and Workforce Upgrading;
   (ii) Mechanization Credit, Productivity Improvement Projects (PIP) and Building Information Modeling (BIM) Funds; and
   (iii) Construction Engineering Capability Development to enable the workforce capability to handle complex projects that are common nowadays.
Up-Down Basement Construction: Schematic Procedure
Up-Down Basement Construction

- Save cost (materials)
- Save space
- Save time
- Safer
Up-Down Basement Construction
Silom Precious (Chareon Krung) Tower, Bangkok, Thailand

*Completed project as standing now.*
Unfinished Building

Similar unfinished building in Bangkok, Thailand during economic crisis in 1997 (Photo taken in 2007)
Productivity in Construction Industry, the BIM Advantages

The key advantages are as follows:

- The overall integration and collaboration of various professionals across the construction industry leading to higher productivity with less conflicts and reworkings.
- Greater cost savings as wastage of resources is reduced, potential problems identified and addressed early at modeling stage via 3-D model.
- Time savings through avoiding repetitive work by various parties, using standardized templates and early rectifying of any design issues.
- Facilitating other value-added onto the project, such as creativity consideration, more green and sustainability design.
Interaction of Work with and without BIM

Without BIM

With BIM
# Strategy and Action Plan for BIM

**Leading Agency:** Building and Construction Authority (BCA)

<table>
<thead>
<tr>
<th>Main Strategy</th>
<th>Action Plan</th>
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<tbody>
<tr>
<td>Leading by public sector.</td>
<td>Working with Government Procurement Entities (GPE) to use BIM in GPE projects from 2012.</td>
</tr>
<tr>
<td>Promoting &amp; building up BIM capability</td>
<td>Introducing BIM Funds as part of CPCF of $250 million. Centre for Construction IT (CCIT) to guide the industry on BIM. Conducting short courses, workshops and seminars for construction workforce on BIM usage and its benefits. Engaging relevant Institutes of Higher Learning (IHL) on BIM training to students. Providing consultation services to the industry.</td>
</tr>
<tr>
<td>Removing obstacles</td>
<td>Developing templates and guidelines to all relevant parties on submission using BIM. Collaborating with professional bodies to set up project collaboration guidelines and object library standards.</td>
</tr>
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</table>
**BIM e-Submission System**

**Leading Agency:** Building and Construction Authority (BCA)

Construction Real Estate NETwork (CORENET) was adopted as the platform for BIM e-Submission. In 2010, nine Singapore regulatory agencies (BCA, CBPU, FSSD, HDB, JTC, LTA, NParks, PUB, and URA) accepted architectural 3-D BIM submission via CORENET. The structural, M&E and plumbing 3-D BIM e-submissions was permitted in 2011. Standardized templates and guidelines with instructions are provided for BIM e-submissions.

BIM e-Submission is to be adopted by 80% of the construction industry by 2015. This forms part of the plan to increase the productivity of the construction industry by 25% over the next decade.
BIM e-Submission System

Target Dates:

Architectural BIM e-Submission is mandatory by 2013 for projects with floor areas greater than 20,000 m².

Structural and MEP BIM e-Submission is permitted in April 2011 and is mandatory by 2014 for projects with floor areas greater than 20,000 m².

All BIM e-Submission is mandatory by 2015 for projects with floor areas greater than 5,000 m².

According to BCA annual report, 386 BIM e-submissions have been made by 88 projects in 2010.

Notable Projects in Singapore Adopting BIM

ArtScience Museum, Marina Bay, Singapore

Singapore Sports Hub
You are cordially invited to the Seminar titled “Building Information Modeling (BIM) in Civil & Structural Engineering” which will be held as follows:

Date: Friday, 19 August 2011
Time: 3.00 pm to 5.00 pm
Venue: Lecture Theatre 2 (LT2), Faculty of Engineering, NUS

The Seminar will be delivered by the following Distinguished Speakers:

Mr Sonny Andalis
Technical Consultant & Structural BIM Specialist
Centre for Construction IT, BCA

Mr Kelvin Ng,
Technical Specialist, Tekla (SEA) Pte Ltd

Mr Madhan Elumalai,
Senior Application Engineer, Structural Software products, Bentley Systems Singapore
You are cordially invited to the Seminar titled “Building Information Modeling (BIM) in Civil & Structural Engineering” which will be held as follows:

**Date:** Friday, 09 Mar 2012  
**Time:** 3.00 pm to 5.00 pm  
**Venue:** Lecture Theatre 2 (LT2), Faculty of Engineering, NUS

The Seminar will be delivered by the following Distinguished Speakers:

**Mr Sonny Andalis**  
*Technical Consultant & Structural BIM Specialist*  
*Centre for Construction IT, BCA*

**Mr Alfred H’ng**  
*Structural Design Engineer,*  
*Engineering Manager in steel fabricator & Technical Consultant in BIM software developer*

**Mr Phil Lazarus**  
*Senior BIM Specialist, ARUP Singapore Pte Ltd & Faculty member, Singapore BCA’s Specialist Diploma Program*
Topics Covered in BIM Workshop to Students and Professionals

- BIM fundamentals and technology
- BIM tools user interface
- Modelling structure model
- Documenting a project
- Structural Detailing
- BIM E-submission
- BIM for structural analysis
- BIM for integration and interoperability
- BIM future technology
  - Cloud computing
  - BIM Especs
  - ePlanCheck
  - Computer aided virtual environment
  - CFD for wind and energy
  - Automated QS
Regular Workshop on BIM by BCA Personnel to Students and Professionals
Sustainability and Green Environment

Sengkang Floating Wetland

Yishun Pond

Green Environment
Strategy and Action Plan

Incentive Schemes:
- $50 million MND research fund for R&D in green building technologies;
- Bonus gross floor area for higher tier Green Mark ratings;
- $120 million Green Mark incentive scheme;
- $15 million sustainable construction fund.

Legislation and Government to Lead:
- Met minimum Green Mark certified standards since April 2008;
- Existing government buildings to achieve Green Mark GoldPlus standard by 2020;
- Higher Green Mark standards for land sales in strategic growth areas.

Green Professionals:
- To train 18,000 to 20,000 ‘green specialists’ by 2020;
- Created and conducted various courses on sustainability.

Various Outreach Programs:
- Green Sparks Competition;
- Green Building Exhibitions;
- BCA Green Mark Awards;
- Green beyond Borders.
BCA Green Mark Buildings in Singapore

BCA GREEN MARK BUILDINGS IN SINGAPORE


Numbers

47 33 127 239 432 758

Construction, De-construction and Re-construction (*Reduced, Reuse, Recycle*)

Fig. 12  C.K. Choi Building, University of British Columbia

Fig. 13  Panelization of roof structure

Fig. 14  Theoretical disassemblable infill housing project
Recycled Aggregates from Demolition Waste \textit{(Reduced, Reuse, Recycle)}

Demolishing

1. C&D Waste

2. Transport

3. Removal of Foreign Materials

4. Crushing & Screening

5. Storage

6. Transport
Recycled Aggregates

Contaminated Concrete Specimen

Surface Decontamination

Decontaminated Concrete Specimen

Crushing and Sieving

Recycled Concrete Aggregate

Tests on RAC

Tests on RCA

Aggregate benefication using microwave

High Quality Recycled Concrete Aggregate

Tests on RAC

Tests on RCA
Designed for Disassembly (DfD) Solution for Resource Efficient Building

DfD intends to maximize material conservation from building end-of-life management and create adaptable buildings and avoid building removal altogether.

Conceptual Framework (5 levels of analysis & 4 principles)*

<table>
<thead>
<tr>
<th>Levels of Analysis:</th>
<th>Concepts &amp; Key Components:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Systems</td>
<td>Adaptability principles:</td>
</tr>
<tr>
<td>Elements</td>
<td>Versatility, Convertibility, Expandability</td>
</tr>
<tr>
<td>Component or assembly:</td>
<td>Disassembly principles:</td>
</tr>
<tr>
<td>Nonstructural layers</td>
<td>Accessibility, Disassembly information, Durability,</td>
</tr>
<tr>
<td>Subcomponent Material</td>
<td>Reversible connections, Recyclability &amp; Simplicity</td>
</tr>
<tr>
<td></td>
<td>Application: Reduced, Reuse, Recycle</td>
</tr>
<tr>
<td></td>
<td>Assessments</td>
</tr>
</tbody>
</table>

Key features: Connections, Disassembly information and Information management system to support DfD

DfD Information System: DfD Database

Proposed approach of the DfD Design & Database:

Designers (Architect-Engineer) must be aware of so-called “standard” components during the design process.
- Agreement on “standard” components
- Optimum layout to use these “standard” components

Database of precast components available

Current Stock of components
- list the available components with storage information
- Assigning Tag ID

Storage Database (Warehouse)

“Model” Level
- list of used components in the model level

Database of precast components
- list the available “standard” components without storage information

Database extracted from Model
Concluding Remarks

- The keywords, namely, (i) **safety**, (ii) **productivity**, and (iii) **sustainability development** are featured prominently in Singapore construction industry. Singapore BCA has worked out the strategies and action plans and implemented them with remarkable success. The authority always emphasizes on safety in construction industry and is aiming at near zero accidents.

- Singapore has embraced BIM initiatives to improve the productivity of the built environment industry engaging professionals at all levels from various relevant designing aspects all the way downstream to the implementation, construction and documentations for future works.
Concluding Remarks

- Singapore BCA is the leading agency spearheading and expediting BIM usage in the construction industry. Strategies, action plans and target dates have been set and funds provided to promote BIM usage, train manpower at various levels and less pain financially for the industry to switch to BIM.

- BCA emphasizes good design and technologies to enhance sustainability development. The authority has also devised various schemes and outreach programs to encourage all parties including the public to embrace and adopt the best green practices in their daily lives.
A Warm Welcome to Visit Singapore