

Innovation Management in Infrastructure Development

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Innovation Management : Hong Kong Housing Authority's Experience

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Fulfilling the Housing Authority's Mission : Forging Ahead into the Future

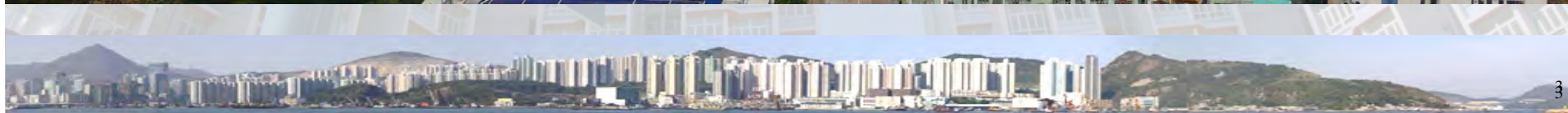
- **Vision**
To help all families in need gain access to adequate and affordable housing.
- **Mission**
 - To provide affordable quality housing, management, maintenance and other housing related services to meet the needs of our customers in a proactive and caring manner;
 - To ensure cost-effective and rational use of public resources in service delivery and allocation of housing assistance in an open and equitable manner;
 - To maintain a competent, dedicated and performance-oriented team.
- **Core Values : 4Cs**
Caring, Customer-focused, Creative, Committed



Hong Kong Housing Authority's portfolio :

- A stock of about **700,000** flats in over 1,100 domestic buildings
- An average production of about **15,000** new flats per year

*We are cash tight but **rich in talents!***



Fulfilling the Housing Authority's Mission : How to apply our **talents...**

According to our Core Values : 4Cs

Caring

Customer-focused

Creative

Committed

Fulfilling the Housing Authority's Mission : Why should we innovate?

Core Values : 4Cs as cornerstone

Committed to **C**aring for **C**ustomers, & be
Creative – We conduct **R**esearch &
Development (R&D) activities, and we drive
innovations.

Research & Development (R&D) Work

- *R&D activities are activities and studies to explore, develop and put into use new processes, products or materials, technologies, and systems in the planning, design, construction and maintenance of public housing development.*
- *Indeed, many of our inventions, be they products, services or systems, have now become part of our daily life and our habit!*

Categories of R&D Work

We categorize R&D according to the *building development and construction processes* : -

- **Planning and design**
- **Materials**
- **Design tools and methods**
- **Construction technologies**
- **Management techniques and performance indicators**
- **Procurement and contracting**
- **Testing, investigation and monitoring techniques**
- **Information technology**
- **Environment and sustainability**
- **Safety**

Managing Innovations :

Developing R&D Strategy
Identifying innovative Trends in the New Era
Developing structures and systems
Monitoring effective implementation
Collaborating with stakeholders

to innovate and advance the frontiers of our human knowledge



R&D Strategy

- **R&D** serves to improve our delivery of the Public Housing Construction Programme.
- Our R&D activities are primarily **applied research** in the field of construction.
- We have identified **innovative trends** – **quantum leaps** in improving the quality of product & process, advancing frontiers of human knowledge, and enhancing human capital. We hope that the industry can **collaborate** with us in spearheading these R&D activities.

We innovate with an aim to enhance :

Sustainability

Safety

Health & Hygiene

Environment-friendliness

Cost Effectiveness

Quality and Durability

Value for Money

We manage R&D with an upward spiral.

We manage R&D work according to a 5-staged life cycle :

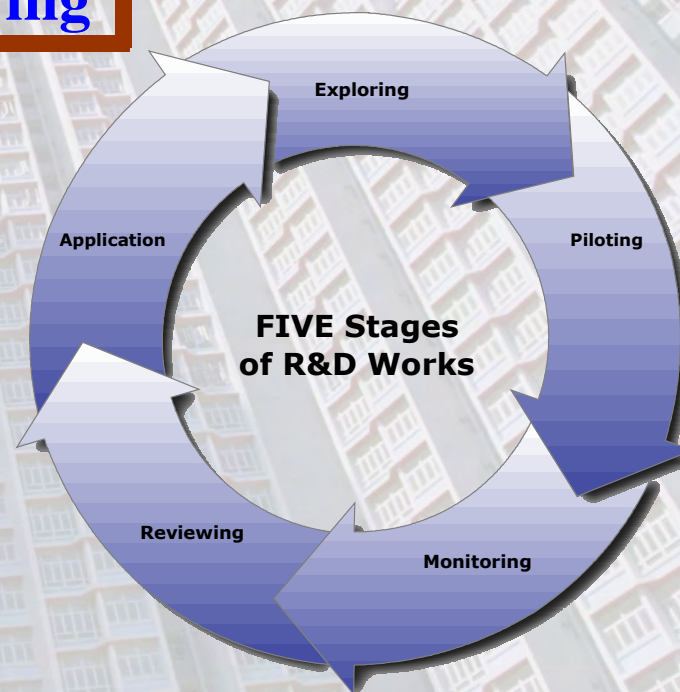
1. Exploration

2. Piloting

3. Monitoring

4. Reviewing

5. Mass Application



Current Stock of R&D Items

<i>Stage of R&D</i>	<i>Number of Items</i>
1. Exploring	11
2. Piloting	26
3. Monitoring	3
4. Reviewing	1
5. Completed	89
6. Mass Application	20
Total as at May 2010	150

How do we drive R&D?

We have different modes for R&D drivers in different periods: -

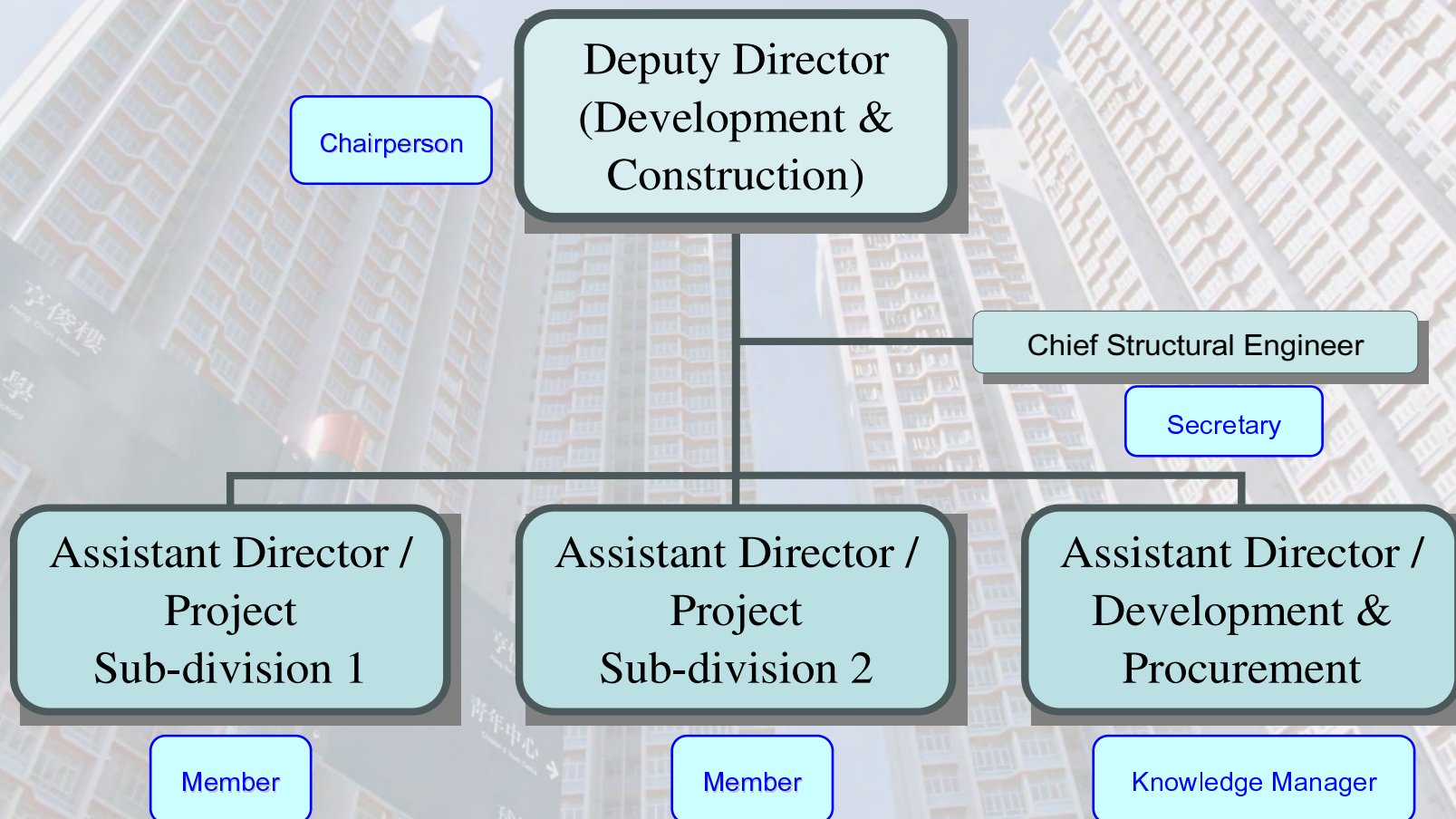
<i>Mode of Development</i>	<i>Period</i>
1. Centrally driven (by Development & Standards Team)	Before 2003
2. Housing Authority Research Fund (Quality Reform in year 2000)	2000 ~ 2005
3. Project-driven (Decentralized)	After HARF since mid 2003 until now

Points, Lines & Plane...

We parallel the mode of Quality Drivers in **3 Generations** -

<i>Mode of R&D</i>	<i>Period</i>	<i>3 Generations of Quality Drivers</i>
1. Centrally driven (by Development & Standards Team)	Late 1980's to 2003	Points : Discrete modules with Task Forces on Quality, Safety, PASS, R&D, Specifications & Standards etc.
2. Housing Authority Research Fund (HARF)	2000 ~ 2005	Lines : Quality Reform, Quality Task Force, HARF Steering Committee
3. Project-driven (Decentralized)	After HARF since mid 2003 until now	Plane : Directorates in R&D Steering Committee, D&C Management Board, Project Teams' ownership

We steer R&D : R&D Steering Committee



We monitor R&D activities.

- **R&D Steering Committee** oversees our R&D work throughout the five stages of its life cycle, from initiation to mass application.
- **Liaison Group on Construction Quality** provides a platform for us to obtain feedback from Estate Management Division and identify strategic areas for R&D.
- **Development & Construction Management Board** monitors the Programme of Activities including R&D performance goals.
- We apply result-oriented guiding principles –
 1. **Cost effectiveness**
 2. **Quality products through innovation**
 3. **Quality housing through sustainable development**

We need Collaboration in the industry!

- **Housing Authority as the client** – initiate, procure and apply innovative ideas in projects including prototyping, piloting and mass application;
- **Academic institutions and professionals** – explore innovative ideas, develop prototypes and take measurements in research;
- **Contractors** – put R&D findings into pilot practice before mass application;
- **Regulators** – consider and approve innovative application for use in HA's projects; promulgate it through circulars where applicable.



We strengthen internal collaboration.

(1) Functional division of work in the organization :

Corporate teams (client & central functions)

VS

Project Teams (project functions)

(2) Multi-disciplinary matrix organization, comprising professional, technical and site staff of different grades -

- **Architects & Landscape Architects**
- **Engineers – CE, GE, SE**
- **Housing Managers**
- **Planners**
- **Surveyors – ES, LS, MS, QS**

We advocate innovation.

**We have about 150 R&D items since year 2000, &
20:80 rule for Corporate team + Project teams.**

Now that we have Project-driven R&D...

R&D is everybody's business!

A hot topic worldwide : R&D for Sustainable Development



R&D for Sustainable Development

Green & Sustainable Planning & Design

- Micro-climate Studies and Air Ventilation Assessment and its Verification
- Vertical Green Panel + Green Roof
- Noise Mitigation Measures – Arc Screen Design and Acoustic Window Design
- Universal design - Tactile Guide Path System with Multi-sensory Map
- Life Cycle Assessment & Life Cycle Costing Method and its Review
- Expected Working Life of Buildings
- Recycled and Green Materials
- Energy saving and Carbon reduction

Health & Hygiene in Design

- Common W-trap system
- Mail Box Type Disposal System for Recycling Materials
- Fungal Resistance Test for multi-layer Acrylic Paint

Advanced Design & Construction Technologies

- Enhanced Structural design
- Precast components
- Quality control on Building Materials and Components

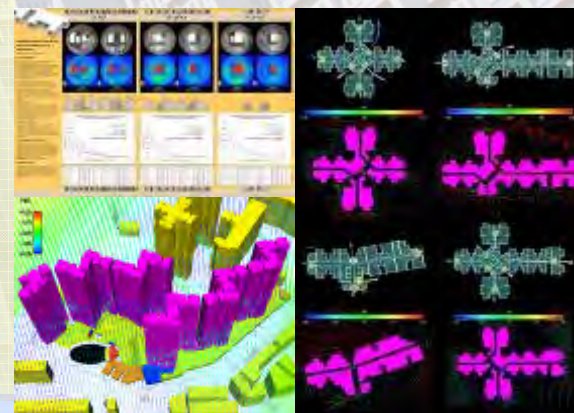
R&D for Sustainable Development : **(1) Green & Sustainable Planning & Design**



Sustainability

Micro-climate Studies & Air Ventilation Assessment

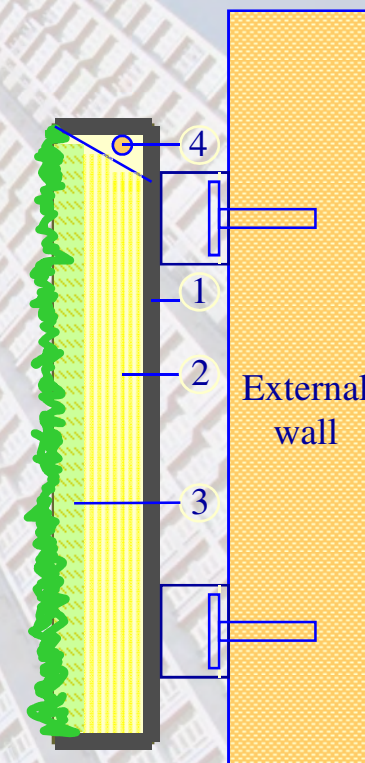
- Since 2004, *micro-climate studies* and *Air Ventilation Assessments* were employed as one of the design tools of public rental housing estates
- Design, orientation and disposition of building blocks is enhanced through optimum use of natural resources such as local wind direction, natural ventilation, daylighting, and solar radiant.



Sustainability

Vertical Green Panel

- The Study for Vertical Green Panel commenced in 2007.
- In collaboration with Department of Biology, Chinese University of Hong Kong and Shui On Building Contractor Ltd..
- In the form of modular prefabricated external cladding.
- Aim of enhance the provision of greening in the congested urban environment.
- Enables easy assembling on-site and future maintenance.
- Carries the multiple benefits of enhancing visual comfort, strengthening ecology and reducing heat island effect.
- Study findings suggested the vertical green panel covered wall is about 16 °C cooler than bare concrete wall in a hot afternoon



Schematic Section of VGP

Schematic Section of VGP

1. Aluminum tray overall size 50 x 100cm
2. 50 mm thick growth medium
3. 25 mm thick soil and grass turf (*Zoysia japonica*, 朝鮮草)
4. Built-in automatic irrigation system



Sustainability

Green Roof

- Providing green roofs in low-rise structures with extensive planting, such as commercial centres, car parks and refuse collection compounds wherever feasible for new housing developments.
- By 2009/10, over 8,000 square meters of green roofs were completed in more than 18 new estates in using different types of vegetation.



Sau Mau Ping South Estate provide green roof or green decking to covered walkways

Pilot Green Estate (Ching Ho Estate in Sheung Shui) provide green roof or green decking to covered walkways, low-rise structures, car parks and/or vehicular access

Yau Tong Shopping Centre

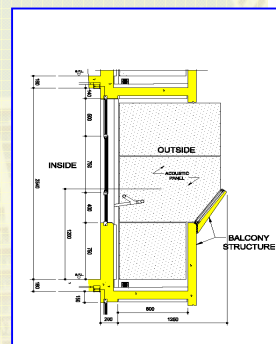


Sustainability

Noise Mitigation Measures

Innovative Arc Screen Design

- Developed an innovative arc screen design to alleviate the traffic noise problem in Sai Chuen Road PRH Development in Sham Shui Po.
- Using a prototype installation in Dongguan to verify by in-situ noise measurements.
- Close liaison with EPD
- Achieve noise reductions of 2.5 dB(A) on the lower floors to 6.4 dB(A) on higher levels.



3- Storey Mock-up at Dongguan



Special Acoustic Window Design

- For more severe noise problem such as sites situated very close to trunk roads with heavy traffic, the design of acoustic windows is being investigated allowing residents to enjoy more open views.
- Laboratory tests of this window design concept gave promising results.



Mock Up Flats for Site Testing

Universal Design Tactile Guide Path System with Multi-sensory Map

- To enhance universal accessibility for all residents including persons with visual impairment in 2005 as an integral part of tactile guide path system.
- Installed at strategic locations of housing estates.
- Provide visual, tactile and voice messages to provide directions for all people, regardless of their age or quality of vision.
- Collaborate with Hong Kong Society for the Blind to develop the multi-sensory map.
- Pilot projects at Redevelopment of Shek Kip Mei Phase 1 and Kwai Chung Estate.
- Multi-sensory map together with tactile guide path system has become a standard provision for new public housing estates since August 2006.



Sustainability

Life Cycle Assessment (LCA) & Life Cycle Costing (LCC) Method

- The HA has, since 2005, developed LCA and LCC method to assess and determine more accurately and effectively the use of new materials at the design stage. New materials which are more environment-friendly and cost effective from the life cycle perspective have been progressively used in pilot projects since 2006. e.g. East Harbour Crossing Site Phase 4 (Yau Lai Estate).
- The Consultants were Business Environment Council, the University of Hong Kong and Davis Langdon & Seah Management Ltd.

- The deliverables were –
 - (a) A LCA & LCC database for >100 building materials; and
 - (b) A computerized combined LCA/LCC “Decision Making Tool”.

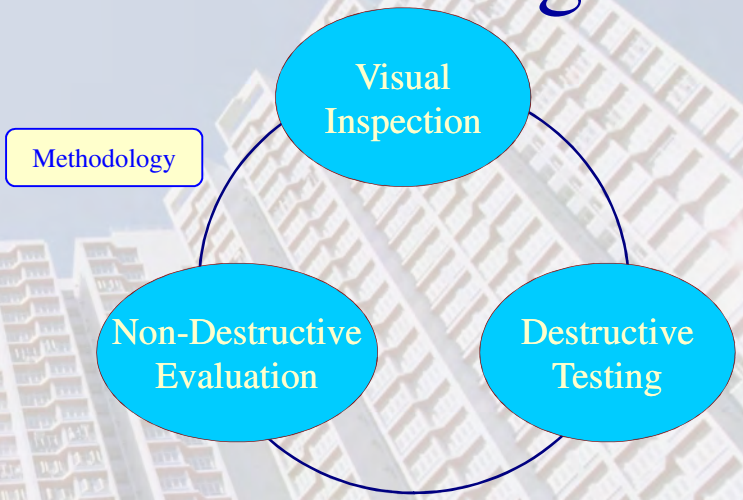
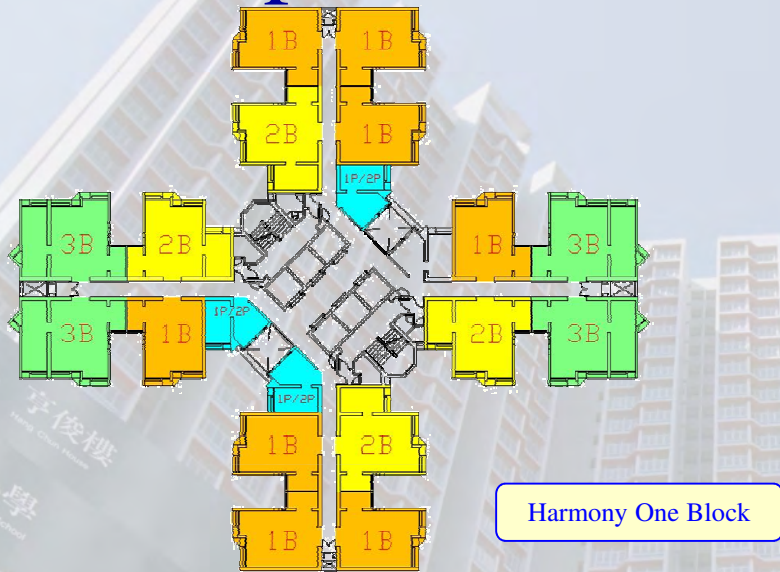
- Final Report has been launched onto HA’s web site for “Knowledge Sharing”.

Way Forward

- *After implementation for 5 years, further review would be carried out for updating and expanding the database of building materials.*

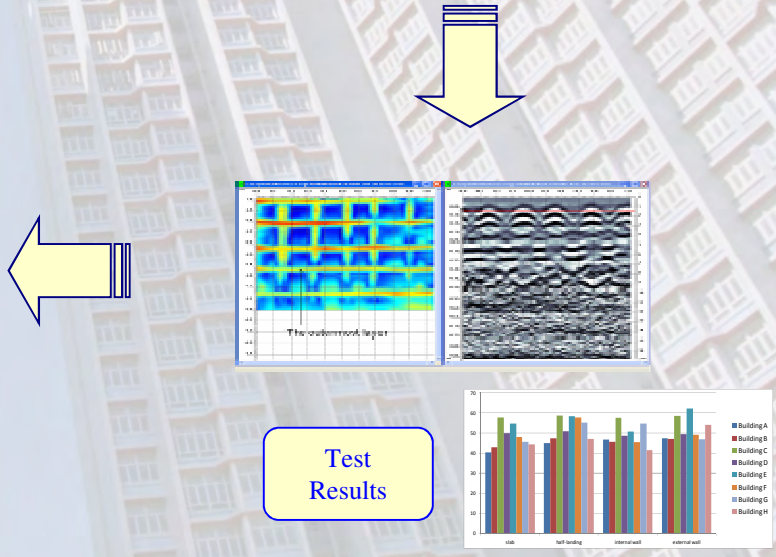


Expected Working Life of Building



Findings

With appropriate maintenance and monitoring regime, working life for housing buildings built after 1992 is at least 100 years...



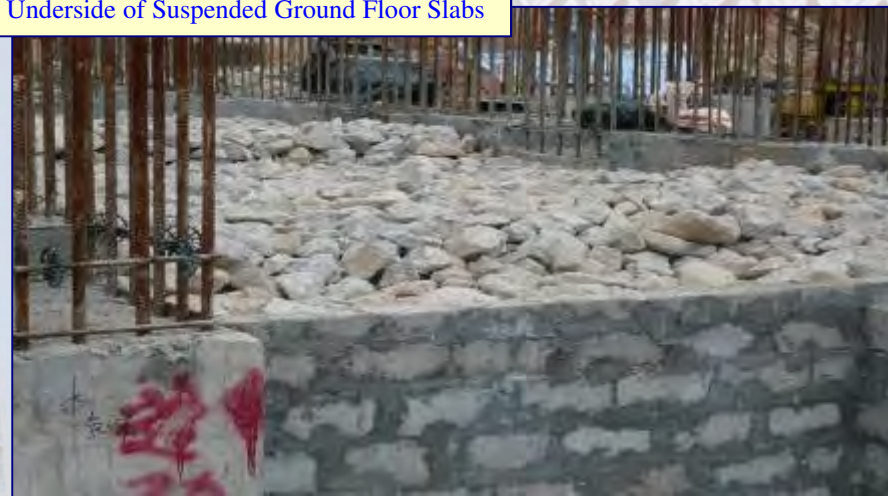
Recycled & Green Materials : Wider Use of Grade 200 Recycled Rock Fill

Benefits

- Sustainable
- Cost Saving
- Time Saving



Backfilling to Voids between Footings/Caps and Underside of Suspended Ground Floor Slabs





Recycled & Green Materials : Recycle & Reuse of Marine Mud

Cement-Stabilisation for Backfilling

- Marine mud is stiff, moist, low strength and high compressibility
- Mix 5% cement and 15% granular material



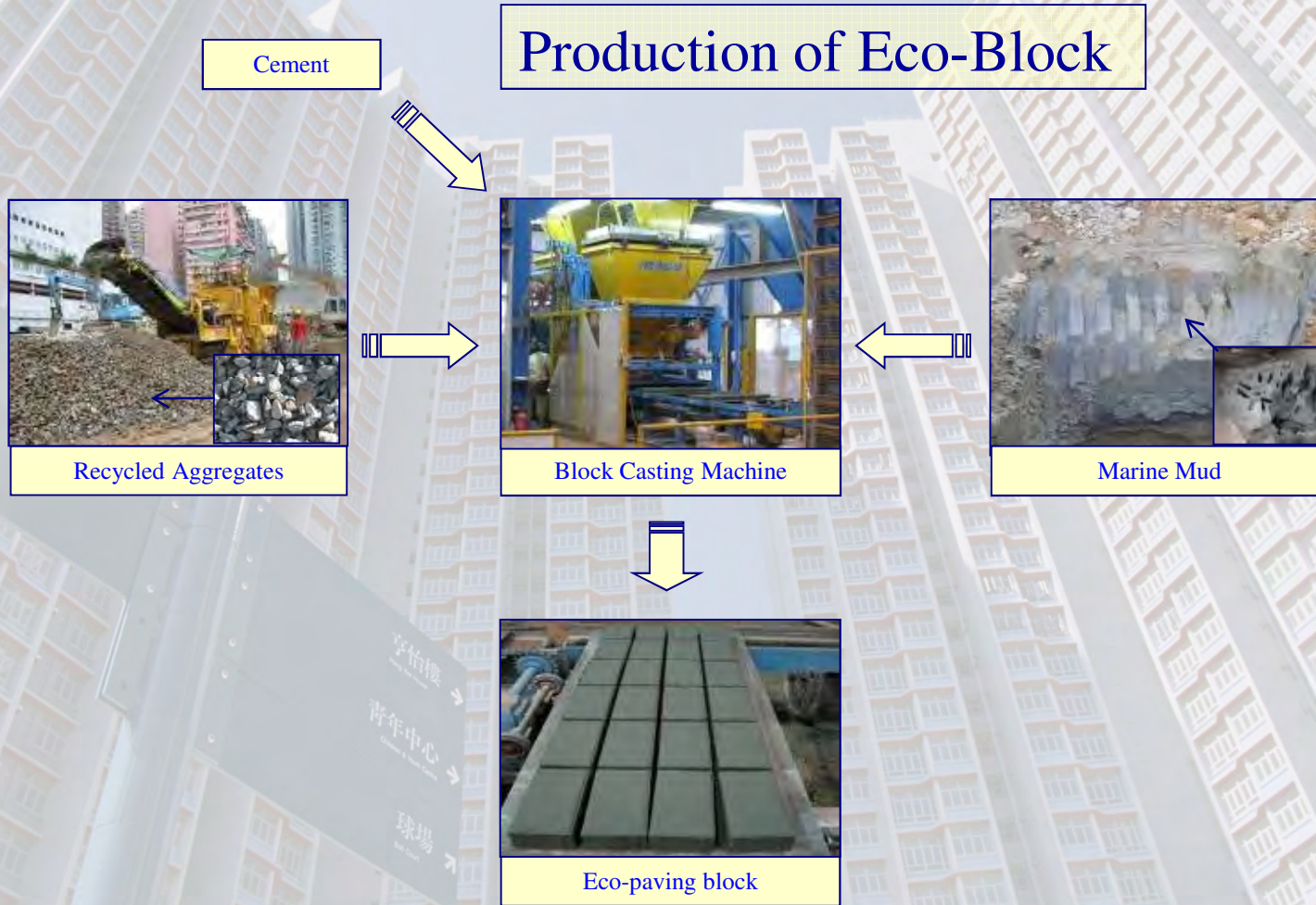
Mix marine mud with other materials



Backfill cement-stabilized marine mud around substructure



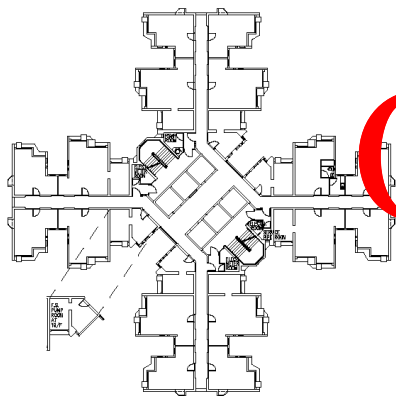
Recycled & Green Materials : Recycle & Reuse of Marine Mud



Building Services : Energy Saving and Carbon Reduction



New Buildings



- 40-Storey Domestic Block
- 20 Flats per floor
- Totally 800 Flats

On Average

596 kWh/Flat

14.4 kWh/GFA (m²)



- HA produces approx. 15,000 Domestic Flats or 20 Domestic Blocks per annum
- For the purpose of estimating the electricity consumption by BS Installations, New Harmony 1 Standard Block is taken as Reference Building

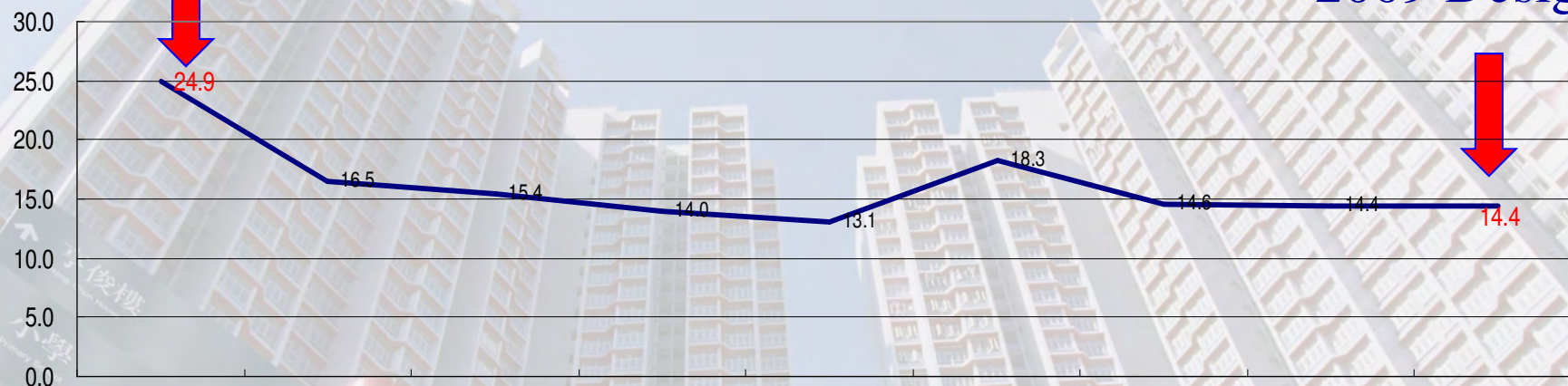


New Buildings How Are We Doing?

2000 Design

kWh / GFA(m²) / Annum

2009 Design



January
2000
Edition

Decrease
illumina-
tion level
of the
lighting
system

Decrease
the
capacity
of all lifts
from
1,000kg to
900kg

Employ
electronic
ballasts in
lighting
system &
T5 tubes
in exit signs

Decrease
the
number
of lifts
from 6 to 5
and
employment
of light
weight lift
car
decoration

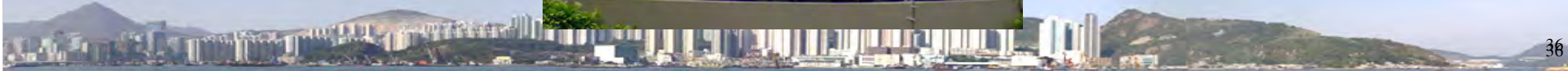
Increase
the
illuminati
on level of
the lighting
system to 85
lux to
comply with
the Barrier
Free Access
Design
Manual

Adopt
New
Lighting
Design
with 2
illumination
levels
controlled
by motion /
photo
sensors and
manual push
switches

Adoption of
Variable
Speed
Drive
System in
Booster
Pumps

Upgrade
motors
from EFF2
to EFF1

Renewable Energy



Renewable Energy Renewable Energy Lighting



R&D for Sustainable Development : **(2) Health & Hygiene in Design**



Health and Hygiene

Common W-Trap System

- The outbreak of SARS in March 2003 has aroused concern from the public over the problem of dried up floor traps with possible transmission of virus into the bathroom / kitchen from a contaminated soil and waste stack.
- Collaboration with Department of Building & Construction, City University of Hong Kong to study the common trap system.
- A series of reiterative tests successfully verified the operational stability.



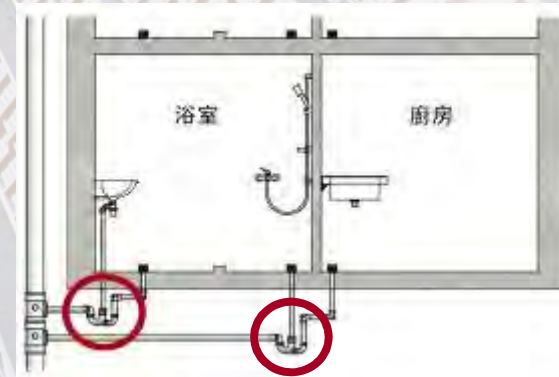
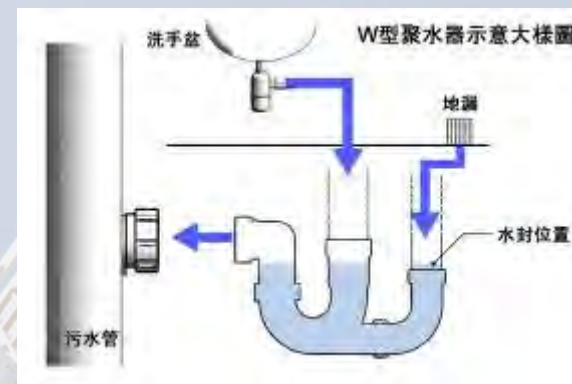
Health and Hygiene

Common W-Trap System

- Buildings Department approved in principle to the use of Common W-trap for connection to the floor drains in toilets and/or kitchens of PRH flats
- Implemented in all new PRH projects since the first completed project, East Harbour Crossing Site 3 (Yau Lai Estate), in 2008.

Way Forward

- *Continue to study on the drainage system to prevent loss of water seal and blockage of pipe at lower floors by adopting fluid dynamic engineering.*



Health and Hygiene

Mail Box Type Disposal System For Recycling Materials

To provide convenience to PRH tenants -

- Provision available on every domestic floor;
- Easily Accessible location from common area i.e. corridor or lift lobby; and
- Easily reachable level by all users (including the elderly and wheelchair users)

To provide Hygienic Environment -

- Separated collecting points with self-closing hatch doors
- Washable finishes; and
- Designated space for collection bins.

Implementation

- The pilot project is East Harbour Crossing Site Phase 5 (Yau Lai Estate) to be completed in Mid 2011.

Way Forward

- *To collect feedbacks from the tenants and the Estate Management; and to further enhance the users friendliness.*





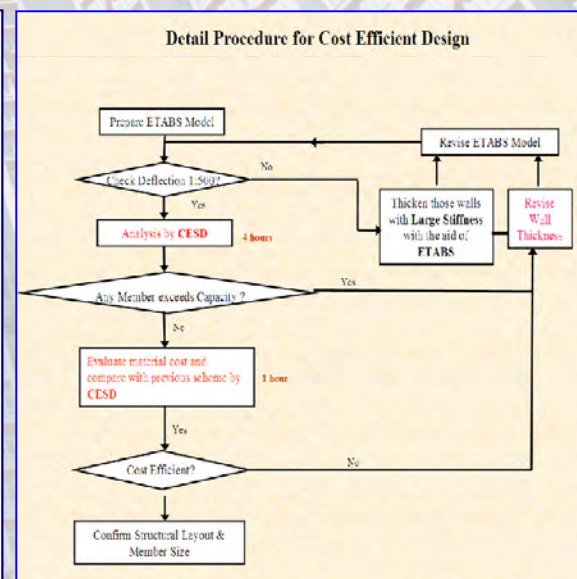
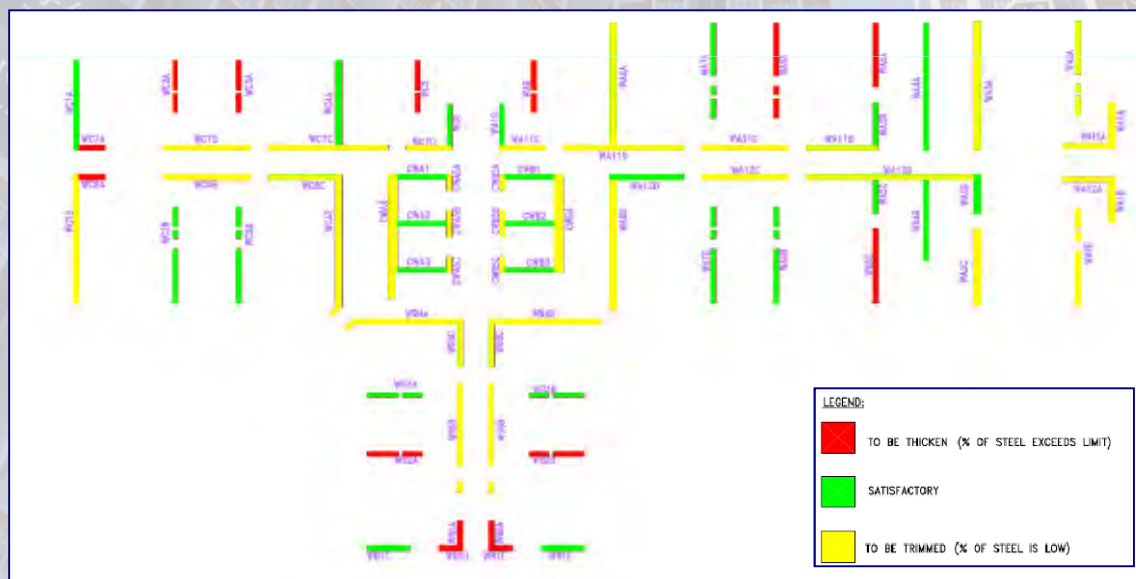
R&D for Sustainable Development :
(3) Advanced Design & Construction Technologies



Enhanced Structural Design Cost-Efficient Structural Design Software (CESD)

Features

- To optimize structural layout and reinforcement quantities
- In-house developed software package validated by HKUST as a proven optimization software applicable to HA residential blocks



Enhanced Structural Design: Reduced Shear Links at Pile Cap and Transfer Structure

Features

- To optimize shear reinforcement provision for thick plate structure i.e. raft footing, pilecap and transfer plate
- Unconventional approach based on sophisticated analysis of stress distribution



Shear Reinforcement



Shear Reinforcement
REDUCED





Precast components : Standardized Precast Facade and Semi-precast slab with Fabric Reinforcement



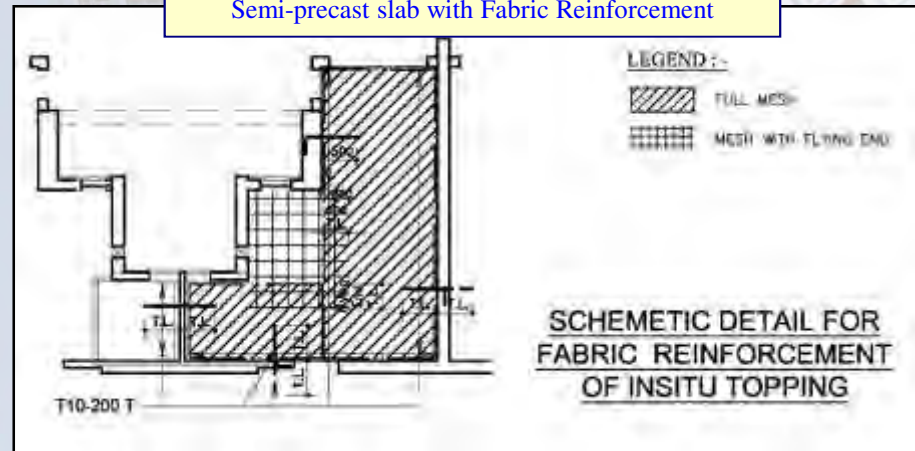
Precast Facade



Traditional Semi-precast slab



Semi-precast slab with Fabric Reinforcement



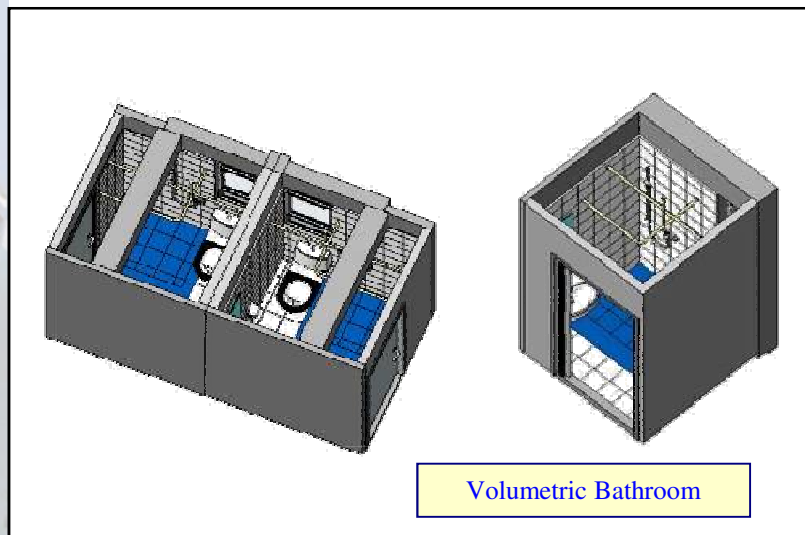


Precast components :

Volumetric Bathroom, Kitchen, Staircore and Liftcore

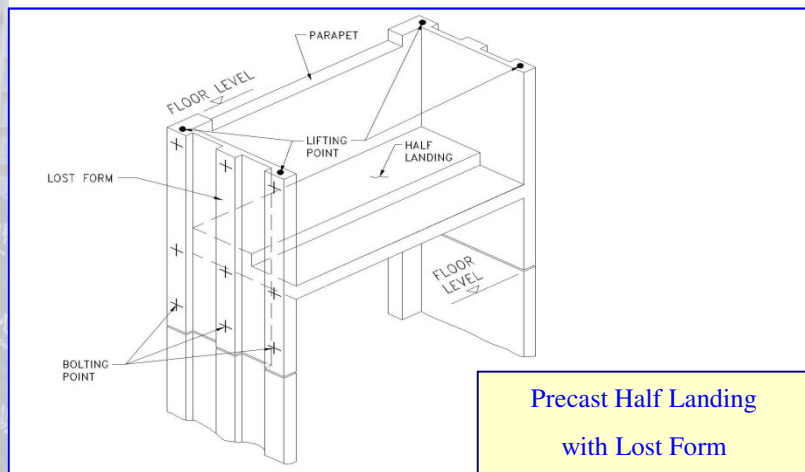
Volumetric precast elements

- give better waterproofing quality, speed of construction and economy of scale
- have great potential for large scale application



Precast Components

- Precast bathroom
- Precast bathroom-cum-kitchen
- Precast staircore
- Precast liftcore





Quality Control : Product Certification

Benefits

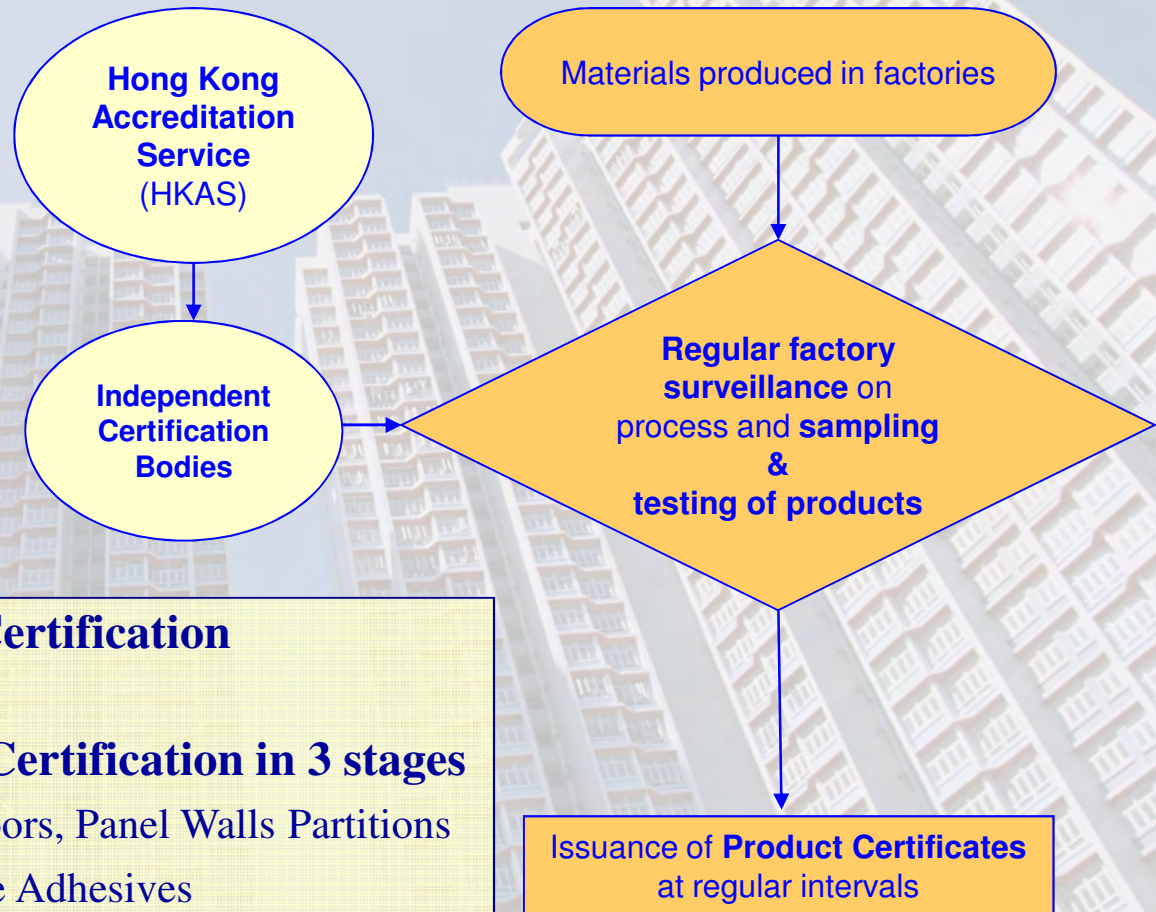
- Greater confidence
- Consistent quality
- Better image
- More business
- Higher competitiveness

Existing Product with Product Certification

- Ready mix concrete (QSPSC)

Coming Products with Product Certification in 3 stages

1. (by 5/10) - Fire Rated Timber Doors, Panel Walls Partitions
2. (by 8/10) - Cement Products, Tile Adhesives
3. (by 12/10) - Tiles, Repair Mortars



Quality Control : RFID on Building Component, Concrete Cube, Concrete Truck and Dump Truck

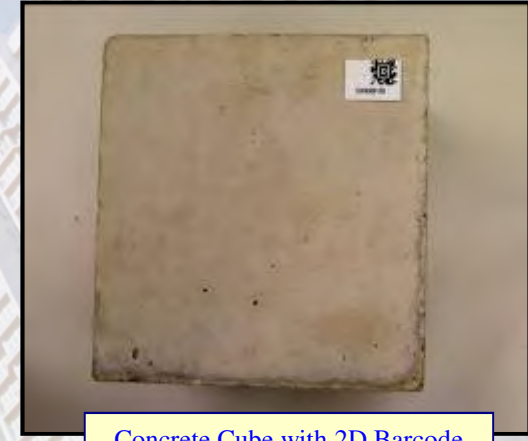
Benefits

- Unique Identification
- Improve Traceability
- Enhance Data Management
- Real time Monitoring
- Minimize human errors
- Streamline the Work Flow

Extend RFID application to concrete cubes, concrete and dump trucks



Barcode Reader taking reading



Concrete Cube with 2D Barcode



Different Types of RFID Tags



RFID Tag installed inside the facade



Advocating Innovation

Next we examine a few innovative trends.

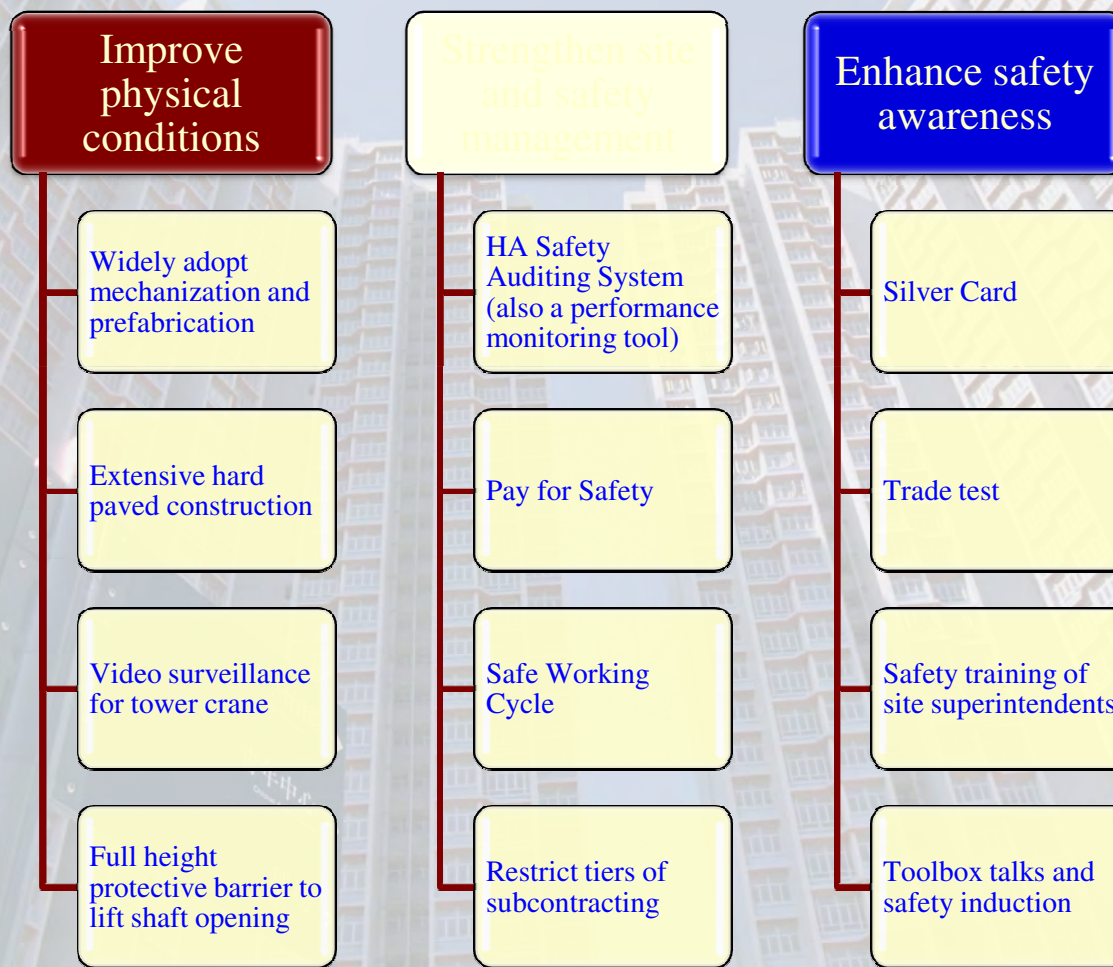
- 1. Site Safety**
- 2. Procuring for Innovations (3-envelope System)**
- 3. Building Information Modeling (BIM)**

Innovative Trends (1)

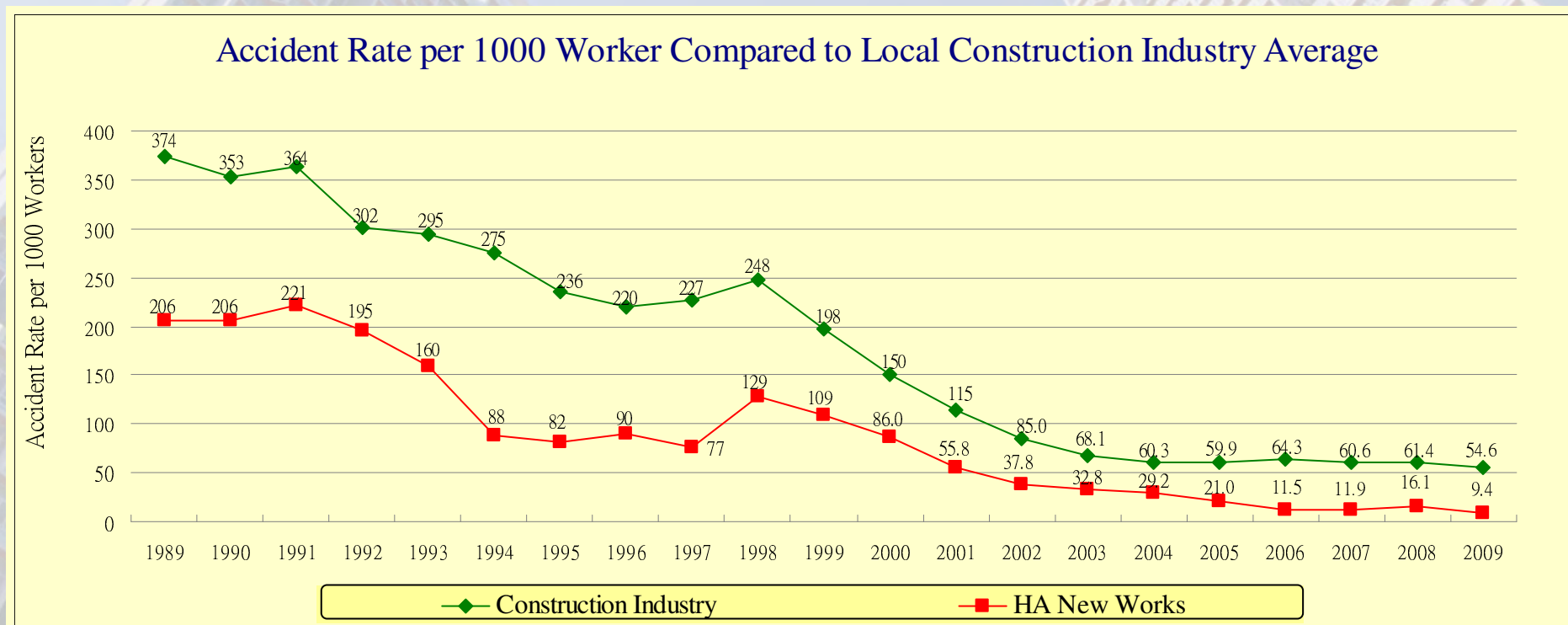
- 1. Site Safety – It is never safe enough!**
- 2. Procuring for Innovations (3-envelope System)**
- 3. Building Information Modeling (BIM)**

Site Safety - (1) Promoting Safe Practice

The three directions in promoting safe practice - **above and beyond regulatory standards**



Site Safety - (2) Tracking Safety Performance



Site Safety - (3) Behavioral Issues & Challenges

Safety Climate Index Surveys

- 794 returns from 9 new works building contracts (2008)

OBSERVATIONS

STRENGTHS

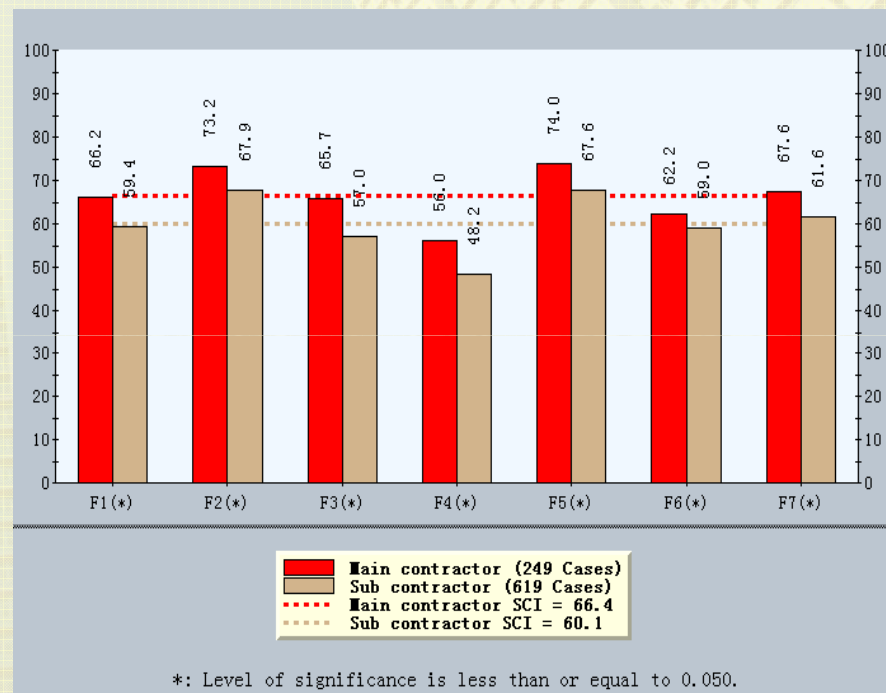
- Factor 2 - Safety Resources and Support
- Factor 5 - Personal Involvement in Safety and Health

AVERAGE

- Factor 7 - Safety Promotion and Communication
- Factor 1 - Corporate and Management Commitment

WEAKNESSES

- Factor 6 - Safe Working Attitude
- Factor 3 - Awareness of Risk-taking Behaviour and Hazards
- Factor 4 - Perception of Safety Rules and Procedures



Site Safety - (4) Performance Monitoring

System enhancements

HASAS version 1.4 from January 2009 and onwards

- Mandate checking of tower crane lifting operation
- Instigate generic checklist for high risk activities
- Introduce “Critical Pass” elements
- Forge Safe Working Cycle, Safety Climate Index
- Strengthen link to Pay for Safety Scheme



Regulatory Actions

- Unsatisfactory safety performance, occurrence of serious accident or near miss incident with potentially serious consequence
 - **Trigger CRC to interview** the contractor
 - **Additional safety audit**
 - **Close monitoring** of the contractor's safety performance



Innovative Trends (2)

1. **Site Safety**
2. **Procuring for Innovations (3-envelope System)- How can we get plenty of innovative ideas despite a tight budget?**
3. **Building Information Modeling (BIM)**

Procuring for Innovations : Incentivizing Innovations

Remember ‘2 Envelope Systems’?

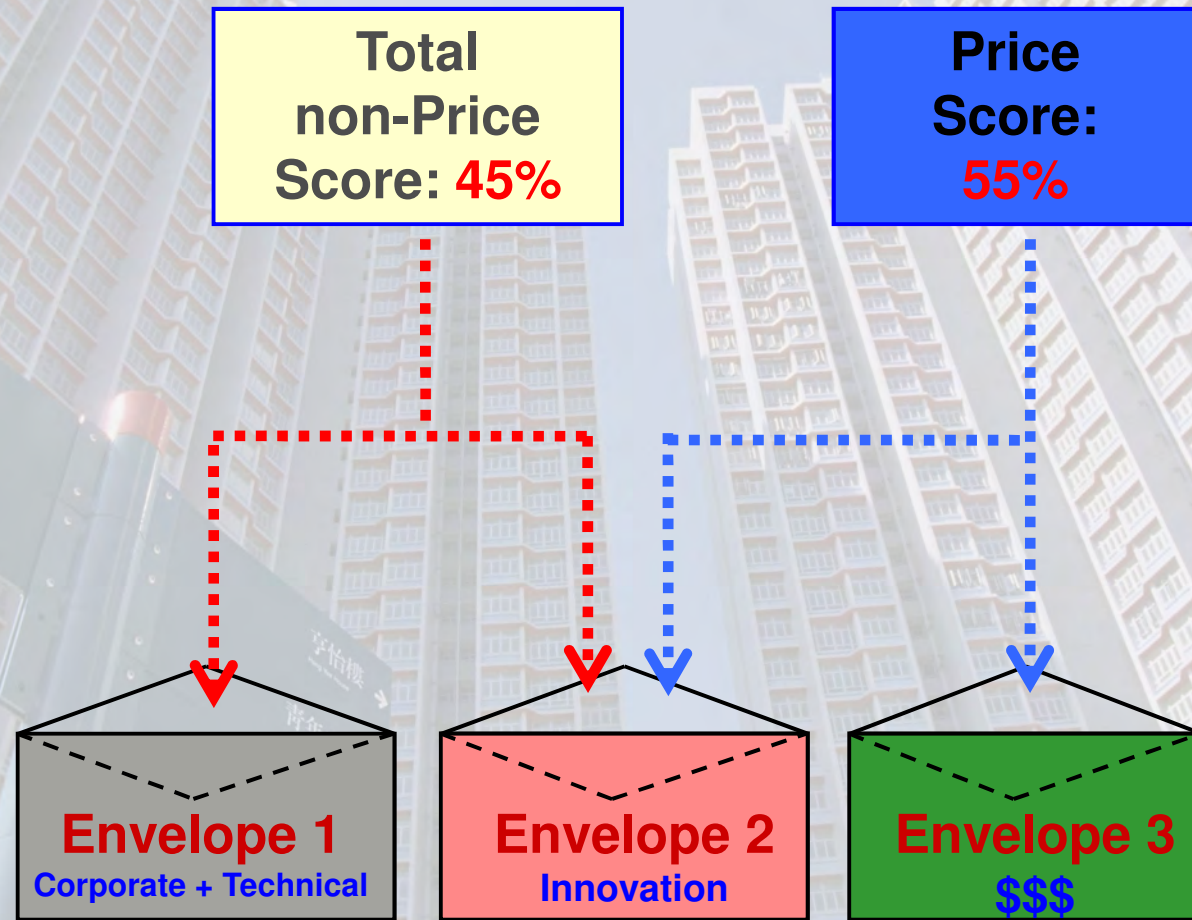
– to select **designers** (or ‘**contractors**’) based on evaluation of both
(1) Technical and (2) Price - envelopes (proposals)

- HK Housing Authority aims to move Construction **from 4Ds to 4Cs:**
from Dirty, Dangerous, Demanding, Damaging/ Disruptive
to Caring, Customer-focused, Creative, Committed
launched a ‘**3 Envelope**’ System in 2009, with the additional Envelope requiring Tenderers to propose any **specific Innovations**.
- **1st (Technical) envelope** only relates to Client Design and proposal,
hence must conform to that.
- **But 2nd envelope** will list any ‘alternatives’ as **innovations** (in 2a);
and secondly list corresponding **benefits** and **costs** (in 2b).
- **Unsuccessful tenderers** will be paid a one-off lump sum for acquisition of
intellectual property right **for their innovations**, specially on Design & Build
projects as in the **pilot project now underway**.





Procuring for Innovations : The Three-envelope System





Procuring for Innovations : Assessment, Scoring & Selection of Innovation Proposals

Step 1 – Open *Envelope 2a* and Assess Technical Submissions



Step 2 – Open *Envelope 2b* and Prioritize Proposals



Step 3 – Select Proposals



Innovative Trend (3)

1. **Site Safety**
2. **Procuring for Innovations (3-envelope System)**
3. **Building Information Modeling (BIM) – How to avoid clashes and wastes in design and construction in this 3-dimensional and 4-dimensional world?**

Building Information Modeling (BIM)

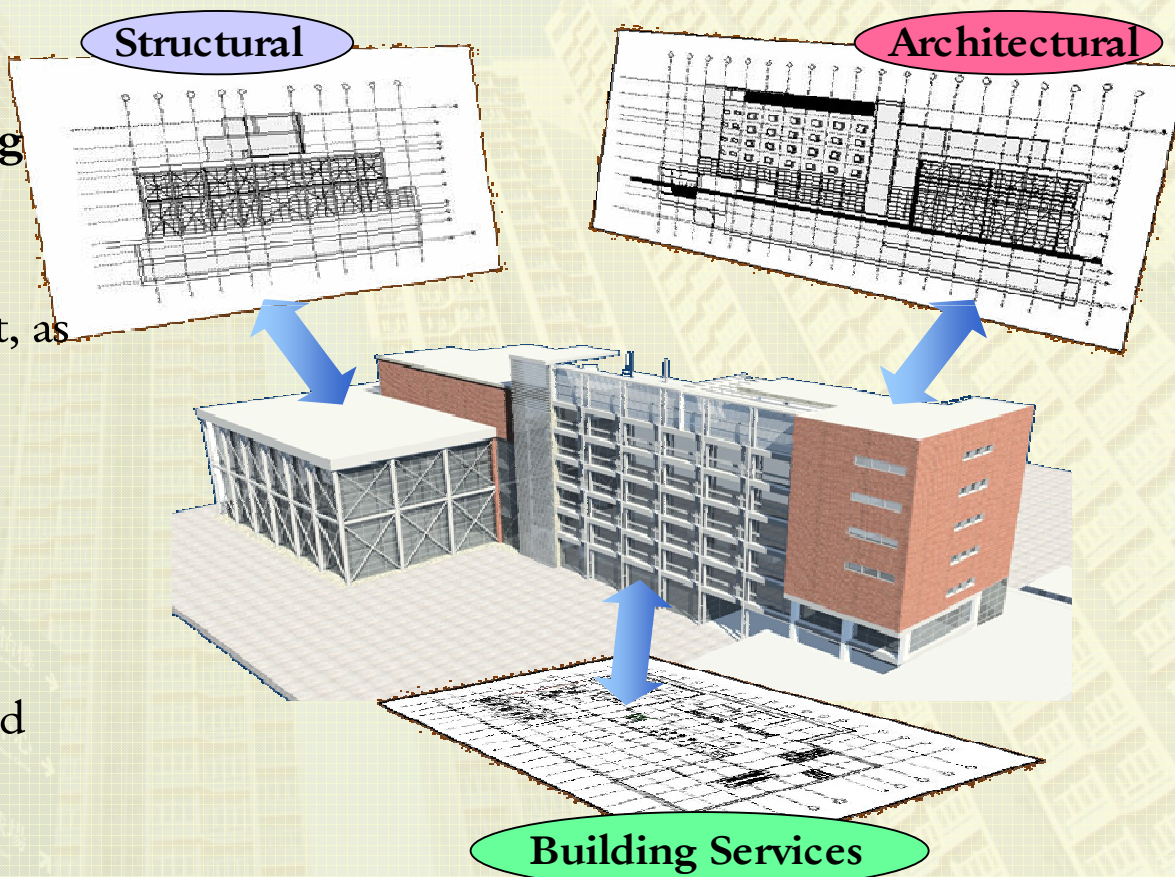
BIM Introduction

The creation and use of **coordinated, consistent, computable information** 3D presentation about a building project in design and construction

Building - The design project, as you envision it for the client

Information - information embedded in the building components

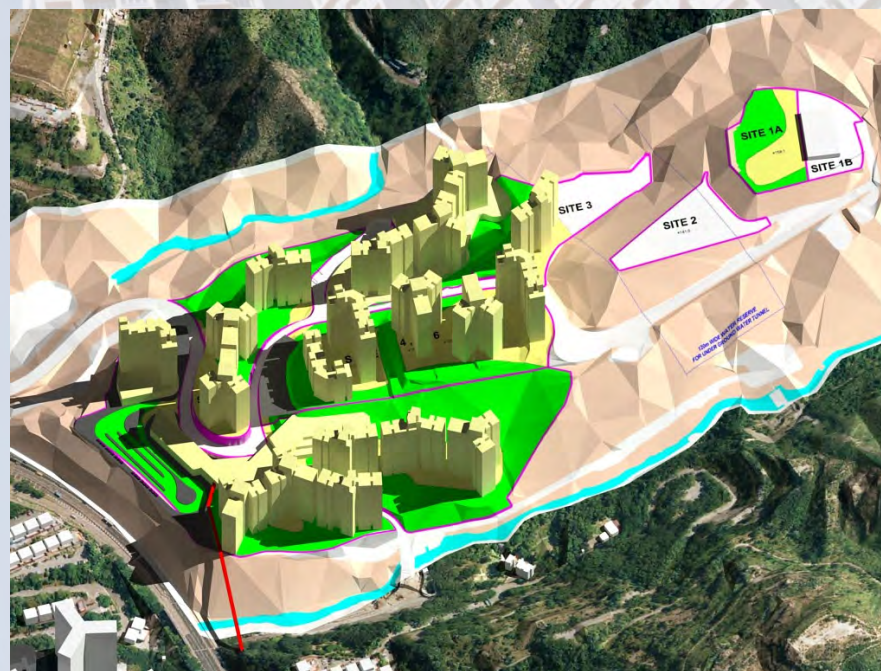
Modeling - The digital description that can be explored and evaluated before you build



Building Information Modeling (BIM)

Terrain Modeling

Planning



Building Information Modeling (BIM)

Site Context, Visual and Environmental Impact

Planning





Building Information Modeling (BIM)

Optimization of Design by an Integrated Team of Innovators

Scheme Design

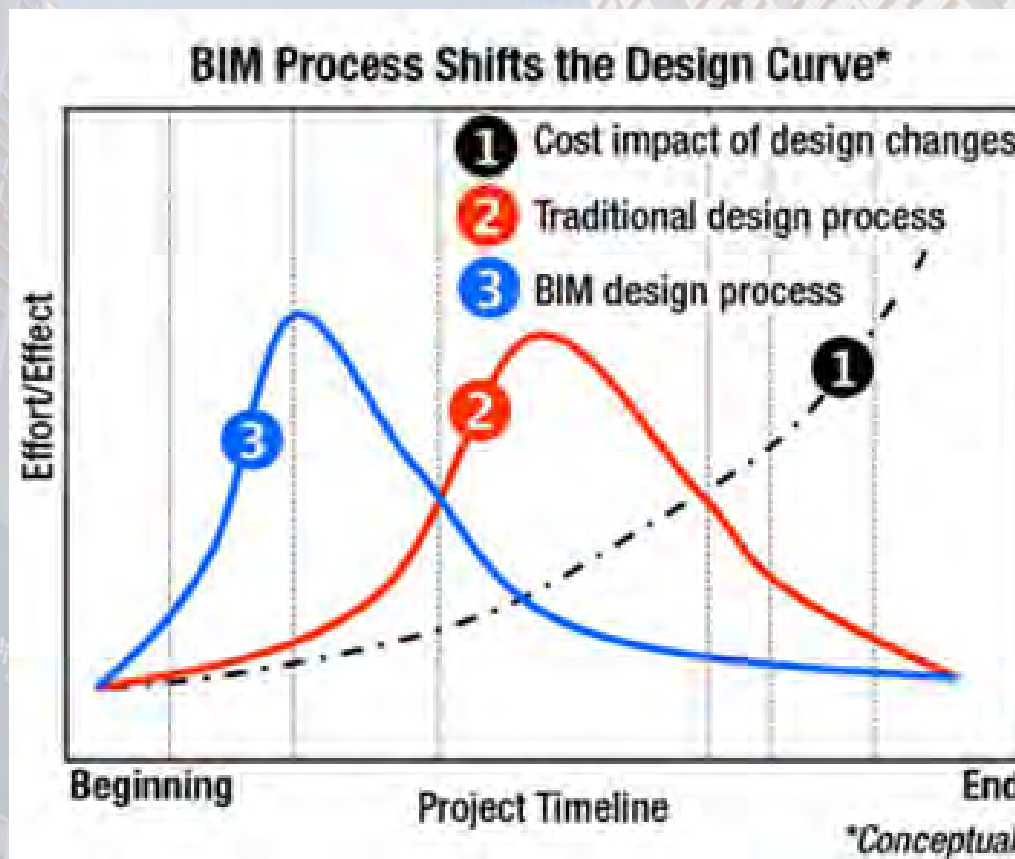
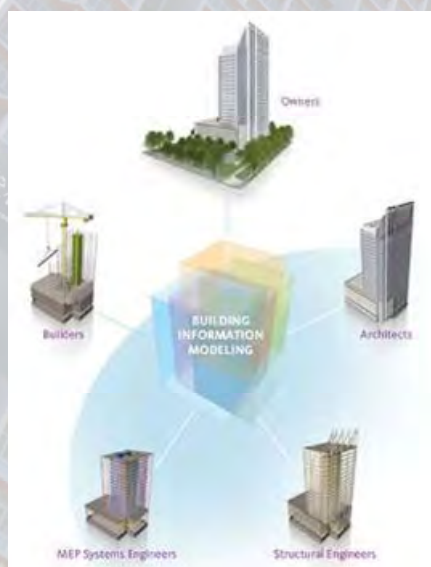


- Arch
- SE
- BSE
- CE
- GE



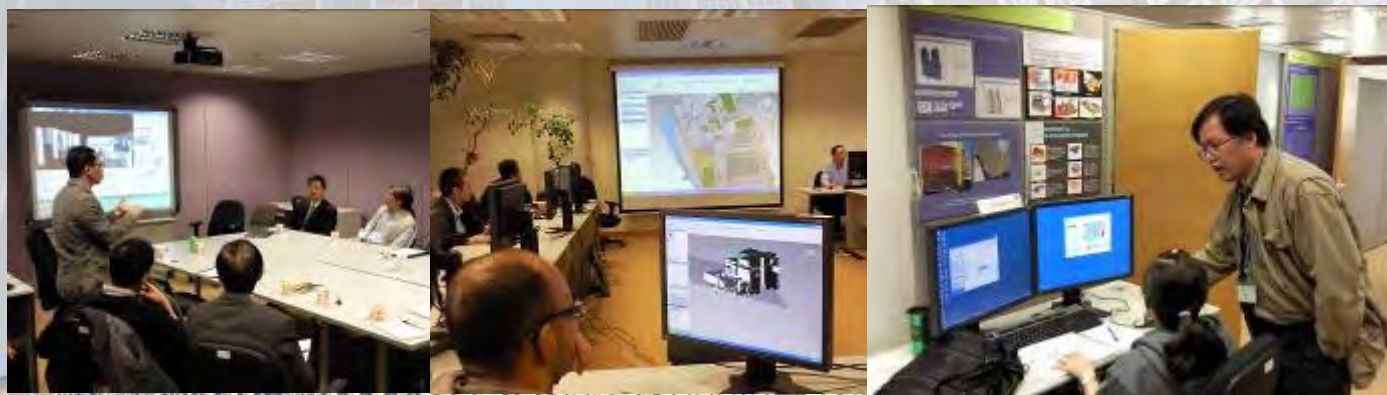
Building Information Modeling (BIM) BIM Process Shifts the Design Curve

Patrick MacLeamy, CEO of HOK



BIM Centre at 12/F, Block 3, HAHQ set up in 2009

- Facilitate sharing of BIM skill & promote its use
- For training and demonstration, design review and group discussion
- For project teams and consultants to work together on BIM projects
- For testing of new software and hardware



Impossible > Impractical > **Possible** >
Expected > Required



Way Forward for HA

- R&D is in our DNA, plus HA's core value of 4Cs in our genes. **R&D is everybody's business.**
- Continuous improvement with R&D and innovation is part of our **business culture.**
- We will continue to work in **partnership with the industry** for sustained quality improvements, through R&D and innovation.



We need Collaboration!

- **Housing Authority as the client** – initiate, procure and apply innovative ideas in projects including prototyping, piloting and mass application;
- **Academic institutions and professionals** – explore innovative ideas, develop prototypes and take measurements in research;
- **Contractors** – put R&D findings into pilot practice before mass application;
- **Regulators** – consider and approve innovative application for use in HA's projects; promulgate it through circulars where applicable.

Food for Thought

千里之行，始於足下
The journey of a thousand miles start with a small step.

行百里者，半於九十
Walk 100 miles, and 90 is the half-way mark.

Rome is not built in a day...

If we can do better, good is not enough!
+ The best is the enemy of the good.



Trick for Success in R&D!

Teamwork

Recognition & Rapport

Integrity & Integration

Creativity & Courage

Knowledge sharing



I would like to leave you all with a thought for today.
This one is attributed to **George Bernard Shaw**. He said :-

"If you have an apple and I have an apple and we exchange these apples, then you and I will still each have one apple. But if you have an idea and I have an idea and we exchange these ideas, then each of us will have two ideas."

Thank you!