Driving Innovations for Green Infrastructure Components

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The design of the Zero Irrigation System received Merit Award (Research) under the Landscape Design Awards 2014 granted by the Hong Kong Institute of Landscape Architects and Merit Award (Research and Planning Category) under the Green Building Award 2014 granted by the Hong Kong Green Building Council.
Background

Researches
(a) Sustainable planting system for Roof Greening
(b) Cost effective Vertical Greening System
(c) Rain water harvesting system with bio-retention mechanism
(d) Root Zone Irrigation System for Ground Cover and Shrubs
(e) Zero Irrigation System (ZIS) for Ground Cover, Shrubs and Small Trees

Conclusion
Background
Introduction

Hong Kong Housing Authority (HKHA) implements one of the world’s largest public housing programme

Housing Estates in Hong Kong

- Adopt functional and cost-effective design in the Planning, Design, Construction and Management of housing projects;
- Promote healthy living and green environment in the work;
- Act with caring and partnering culture beyond baseline performance.

756,000 flats in use

280,000 new rental & subsidized sale flats from 2017/18 to 2026/27

2,140,000 (30%) population

14,000+ workers daily

99 listed contractors

80+ active suppliers

9,000+ HA staff
Our Vision
To help low-income families with housing need gain access to affordable housing.

Our 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; and
• To maintain a competent, dedicated and performance-oriented TEAM.
Greening Mission in Housing Authority:
- To plant at least one tree for every 15 flats since 2000.
- Achieve overall target of 30% green coverage for all new housing projects since 2010.

Green Infrastructure Components:

**Building**
- Green roofs
- Vertical greening

**Water**
- Rain water harvesting
- Water saving irrigation system

**Landscape**
- Bio-retention
- Plant Selection

**Hardscape**
- Pervious pavement
Roadmap for greening in Public Housing Development

2010

- Slope greening study

2011

- Vertical greening research

Green roof research

2012

- Root zone irrigation system

2013

- Zero irrigation planting system

2014

- Bio-retention system
Researches
Objectives:

• To establish a low-maintenance green roof.
• Compare the growth performance of two commonly used green roof plant species (Sedum mexicanum 金葉佛甲草/ Arachis pintoi 蔓花生).
• Test the environmental performance of the green roof systems.
Green Roof Research Findings

**Heat Reduction** - the green roof surface is 18.9°C cooler than roof surface without thermal insulation.

**Plant performance** –

*Sedum mexicanum* 金葉佛甲草 and *Arachis pintoi* 蔓花生 should be promoted in consideration of it’s long term low maintenance requirement.
(B) Cost effective Vertical Greening System

Objectives:

• To evaluate:
  (i) heat reduction capacity,
  (ii) water use efficiency,
  (iii) plant performance & species selection,
  (iv) fertility persistence and nutrient loss.

Heat Reduction - a vegetated wall surface is 16°C cooler than bare concrete wall.
**WATER CONTENT**
The water content of the panels should reach at least 25%. A 1m x 0.5m panel requires 1 liter of water per day.

**PLANT SPECIES**
The study identified the suitable plant species and their combination in terms of colors, contours and appearance to form lively and diversified patterns.

**NUTRITION STRATEGY**
Liquid fertilizers should be applied for a duration of six weeks in spring each year.
(C) Rain water harvesting system with bio-retention mechanism

Rainwater Collected from:

- Green Roofs
- Covered Walkway
- Roof tops of Block
- Planter

Source: AECOM, 2014. Mock-up of bio-retention Rainwater Harvesting System in Shui Chuen O Phase 1—Summary report for Hong Kong Housing Authority
(C) Rain water harvesting system with bio-retention mechanism

Trial at Shui Chuen O Estate

Source: AECOM, 2014. Mock-up of bio-retention Rainwater Harvesting System in Shui Chuen O Phase 1—Summary report for Hong Kong Housing Authority
(C) Rain water harvesting system with bio-retention mechanism

**PRINCIPLES OF WATER TREATMENT**

Pollutants in water are removed through physical and biological processes, effected by soil layers, vegetation and biofilm:

- Physical filtration
- Induced sedimentation of fines
- Biodegradation with oxygen transfer through roots to soil (aerobic microbial processes)
- Nutrient and contaminant uptake by plant and microbes on biofilm as well as retention in the soil matrix
- Absorption of particles and contaminants onto biofilm

Source: AECOM, 2014. Mock-up of bio-retention Rainwater Harvesting System in Shui Chuen O Phase 1– Summary report for Hong Kong Housing Authority
(C) Rain water harvesting system with bio-retention mechanism

Treatment System 1

Bio-retention System at Shui Chuen O Estate

- Bio-retention
- Catchment Area

Plant Selection for Bio-retention

- Setcreasea purpurea
- Tradescantia zebrina
- Cyperus papyrus
- Miscanthus sinensis
(D) Root Zone Irrigation System for Ground Cover and Shrub

ROOT ZONE IRRIGATION SYSTEM

• Supplies water directly to plant roots to minimize evaporation and reduce the amount of irrigation.

• Major components:
  - Polyethylene drip pipes wrapped in special fleece.
  - Irrigation mat enables even distribution of water.
  - Water migrates by capillary effect Mat is installed about 10 to 20 cm below soil surface.

RAINWATER HARVESTING AND ROOT ZONE IRRIGATION

FIGURE 1 - SET UP IRRIGATION SYSTEM AND RAIN WATER COLLECTION SYSTEM
Research findings at Tak Long Estate:

- **Water saving** potential is approximately **38%**
  - Plot provided with root zone irrigation system – **1.54 litre/m²/day**
  - Plot provided with manual irrigation – **2.5 litre/m²/day**

Maintenance:

- **No breakdown** throughout monitoring period.
- Sand filter had been cleaned 2 times within a 15 months period.
- **No particular maintenance** was required for irrigation mat.

Limitation:

- Suitable for small vegetation since the mat cannot be installed more than 400mm below soil surface.
Zero Irrigation System (ZIS) for Ground Cover, Shrubs and Small Trees

ZIS includes two main mechanisms:

1. **Sustainable Urban Drainage System (SUDS)**
   - Decentralized network of site-specific storm water management techniques.
   - To reduce / defer the volume of storm water runoff entering the sewer system
   - Restoring the natural hydrologic cycle (water recharge)

2. **Sub Soil Irrigation System**
   - The sub-irrigation system comprises a wicking mechanism which is a self-sustained and passive design to deliver the storm water stored in water retention cells to the vegetation and to minimize topsoil evaporation through capillary action.
Zero Irrigation System (ZIS) for Ground Cover, Shrubs and Small Trees

ZIS trial at Tuen Mun:

1. Minimize Manual Irrigation Operation and Long Term Maintenance Cost
2. Reduce the Storm Water Runoff Loading + Ground Water Recharge
Zero Irrigation System (ZIS) for Ground Cover, Shrubs and Small Trees

CONSTRUCTION PROCESS

1. Sub-soil Preparation
2. Water-proofing Layer – Sodium Bentonite Layer
4. Water retention cell

4. Water Storage Retention Box
Filter Fabric

7. Planting Soil
5. Wicking Media - River sand
6. Geotextile

5. Wicking Media – River sand
6. Geo-textile between growing media and river sand
7. Growing Media
8. Inspection Point and Water Top-up Pipe

Yearly Water Consumption
1st Water Consumption = 2.6 L/m²/day
2nd Water Consumption = 1.8 L/m²/day

Observation
2.2L/m²/day
Zero Irrigation System (ZIS) for Ground Cover, Shrubs and Small Trees

Summary of findings and observations:

- No manual watering operation and potable water are required.
- Average daily water consumption is less than 2.21L / m² / day.
- Increase water storage capacity of soil & minimize water loss through evaporation.
- No flooding even under black rainstorm warning.
- 5 out of 6 species of plants were well established.
- No odor or any unpleasant smell were detected.
- No particular maintenance is required for components.
- Limitation: Tree planting at pre-designated locations in the planter.
(E) Zero Irrigation System (ZIS) for Ground Cover, Shrubs and Small Trees

Condition of Plant Species - chosen for this trial (Up to May 2014)

- **Cordyline terminalis ‘Tricolor’** (三色龍樹)
  - Drought Tolerant: Low

- **Duranta erecta ‘Variegata’** (花葉假連翹)
  - Drought Tolerant: Low

- **Drejerella guttata** (鴨咀花)
  - Drought Tolerant: Low

- **Nephrolepis exaltata ‘Bostoniensis’**
  - Drought Tolerant: Low

- **Schefflera arboricola ‘Variegata’**
  - Drought Tolerant: Low

- **Sansevieria trifasciata ‘Golden Laurentii’**
  - Drought Tolerant: Low

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Organisers:
- CONSTRUCTION INDUSTRY COUNCIL
- HKGBC
- SBE SERIES
- Global Alliance for Buildings and Construction

International Co-owners:
(E) Zero Irrigation System (ZIS) for Ground Cover, Shrubs and Small Trees

Tree performance at tree corridor along ZIS

• In November 2013, trial on shrub planting with ZIS was installed.
• In September 2014 onwards, no more manual watering was carried out for the corridor adopting ZIS planted with 4 nos. heavy standard tree.
• In November 2015, the project had been handed over to Housing Management Office as scheduled.

Observations

• The growth of all trees adopting ZIS was in good condition.
• There was no sign of suffering due to lack of water.
• No flooding was observed.
Way forward
(D) Way Forward

ZIS detail with Tree Planting

Typical Section of ZIS planter

a. Water Retention Box
b. Geo-textile
C. Sodium Bentonite
(D) Way Forward

- Conduct further study and explore more economical material to refine the system, particularly modular type ZIS, to achieve a more cost effective design and to reduce the capital cost as far as practicable
- Collaborate with academia to optimise ZIS design
- Design ZIS with tree pits to facilitate tree planting
(D) Way forward

Sharing with the industry:
Researches and innovations are the key to improving our planning, design and delivery of public housing. These are carried out both in-house and in collaboration with academia, industry specialists, business partners and other related stakeholders.

Our ultimate goal is to integrate all these knowledge and technologies in public housing development and for the benefit of the society.

Website for sharing with the society  www.housingauthority.gov.hk
Thank you

For details of Hong Kong Housing Authority’s Sustainability Initiatives, please visit –

English Version

Putonghua Version

Cantonese Version