Prospects of building greening in Hong Kong

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(More information: http://ibse.hk/greenroof/)
Contents

• Introduction
• Green roofs
• Vertical greening
• Potential benefits
• Sustainable technologies
Introduction

• Skyrise greenery 天際綠化
  • Greening at the buildings or other structures beyond the ground level, such as
    • Roof greening (horizontal or inclined)
    • Vertical greening
    • Sky gardens, podium gardens
    • Terrace and balcony planting
    • Edge greenery
  • Multi-level greening
  • History
    • Hanging gardens of Babylon (600 B.C.)

The Hanging Gardens of Babylon (an ancient wonder of the world)

(Video: Gift for a Queen - Hanging Gardens of Babylon (2:44) http://youtu.be/Kfg1YE-BqTc)

(Source: http://weburbanist.com; see also http://en.wikipedia.org/wiki/Hanging_Gardens_of_Babylon)
Introduction

- **Skyrise greenery in modern world**
  - High-density urban cities
  - Highrise buildings and concrete jungle
  - Limited space for greening & relaxing

- **Greenery in urban landscape**
  - Make good use of existing spaces in urban areas
  - Integrate *nature* into our urban development
  - Create urbanscapes that are dynamic in more environmental and sustainable ways
Types of landscape areas from skyrise greenery

Green roofs

- **Green Roofs**: roofs bearing vegetation – FLL*
  - “Living vegetation installed on the roofs”
  - “Vegetated roof” 植被屋頂

- **Green Roof System** – Definition 面頂綠化系統
  - “A roof area of plantings/landscape installed above a waterproofed substrate at any building level that is separated from the ground beneath it by a man-made structure.” – *NRCA Green Roof System Manual 2007*

- Other green roof terms: Eco-roof, Living roof

* FLL = Research Society for Landscape Development and Landscape Design (Forschungsgesellschaft Landschaftsentwicklung Land-schaftsbau e.V.) (www.fll.de)
<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Extensive</th>
<th>Semi-intensive</th>
<th>Intensive</th>
</tr>
</thead>
<tbody>
<tr>
<td>Depth of material</td>
<td>150 mm or less</td>
<td>Above and below 150 mm</td>
<td>More than 150 mm</td>
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<tr>
<td>Accessibility</td>
<td>Often inaccessible</td>
<td>May be partially accessible</td>
<td>Usually accessible</td>
</tr>
<tr>
<td>Fully saturated weight</td>
<td>Low (70-170 kg/m²)</td>
<td>Varies (170-290 kg/m²)</td>
<td>High (290-970 kg/m²)</td>
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<tr>
<td>Plant diversity</td>
<td>Low</td>
<td>Greater</td>
<td>Greatest</td>
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<tr>
<td>Plant communities</td>
<td>Moss-sedum-herbs and grasses</td>
<td>Grass-herbs and shrubs</td>
<td>Lawn or perennials, shrubs and trees</td>
</tr>
<tr>
<td>Use</td>
<td>Ecological protection layer</td>
<td>Designed green roof</td>
<td>Park like garden</td>
</tr>
<tr>
<td>Cost</td>
<td>Low</td>
<td>Varies</td>
<td>Highest</td>
</tr>
<tr>
<td>Maintenance</td>
<td>Minimal</td>
<td>Varies</td>
<td>Highest</td>
</tr>
</tbody>
</table>
Typical structure of extensive green roof

- Vegetation
- Growing medium
- Filter membrane
- Drainage layer
- Waterproofing membrane
- Support panel
- Thermal insulation
- Vapour control layer
- Structural support
Examples of green roofs in the world

Solar Campus Jülich, Germany (11 Jul 2001)  IBN-DLO Wageningen, the Netherlands (2 Jul 2001)

Putrajaya Int. Conven. Centre, Malaysia (30 Jun 2006)  Beitou Taipei Library, Taiwan (6 Aug 2007)

(Photos taken by Dr Sam C M Hui)
Examples of green roofs in Hong Kong

Ocean Park
EMSD Headquarters
Parklane, TST
HK Wetland Park

(Photos taken by Dr Sam C M Hui)
Collapse of green roof in Hong Kong (20 May 2016)

Overloading due to:
1. Thickening of screeding
2. Green cover layers
3. Localised water ponding (rainwater and poor drainage)

(Image source: http://hk.apple.nextmedia.com/)
Another type of green roof in Hong Kong
Vertical greening

- **Vertical greening** – descriptive terms
  - Green walls, living walls, bio-walls, living wall/cladding, green facades, vertical green, vertical gardens, vegetated wall surfaces

- Possible applications:
  - 1. Building façades or outdoor vertical surfaces
  - 2. Interior walls or indoor vertical surfaces
  - 3. Noise barriers (e.g. along the roads)
  - 4. Slopes and site hoarding boards
An example of outdoor vertical greening

Indoor green walls
Green noise barriers

(Source: Highway Department, HK)
Greening on slopes

(Source: Civil Engineering and Development Department, HK)
Vertical greening

- Common reasons for vertical greening:
  - Aesthetic (how it looks)
  - Cognitive (meaning)
  - Experiential (trial use)
  - Planning and financial gains ($)
  - Pollution absorption (air)
  - Ecology (habitats)
  - Fashionable

Do you like Greening?
Green wall example in Taichung, Taiwan

(Source: Dr. Sam C. M. Hui)
Greening on site hoarding boards (Taiwan) 綠化圍板（台灣）

(Photo taken by Dr. Sam C. M. Hui)
Indoor green wall in a subway station (Taipei)

(Source: Mr. Eddie Tse)
Potential benefits

• Green roofs & vertical greening
  • Building integrated vegetation
  • Urban cityscape
  • Green infrastructure

• Possible benefits:
  • 1. Environmental
  • 2. Economic
  • 3. Social & aesthetics
Potential benefits

1. **Environmental benefits:**
   - Mitigate urban heat island
   - Improve air quality
   - Stormwater management
   - Create natural habitat
   - Increase biodiversity
   - Insulate and absorb sound
   - Possible urban farming
Urban heat island effects in Hong Kong and Singapore

Potential benefits

2. **Economic benefits:**
   - Improve roof durability
   - Increase roof material lifetime
   - Reduce building cooling load and energy costs
   - Provide open space & increase property value
   - Attracts buyers and tenants
   - Attracts and retains employees
   - Green building credit points & image
Potential benefits

3. **Social & aesthetic benefits:**
   - Aesthetic for urban space (natural outlook)
     - Relief from concrete construction
   - Provide usable green space for sports & leisure
     - Community gardens, recreational/relaxing space
   - Community participation for greening
     - Such as urban agriculture
   - Enhance local employment
     - For greenery installation & maintenance
Potential benefits

• Other possible benefits:
  • Urban farming (e.g. growing vegetables, herbs)
    • Make best use of roof space; may be organic
  • Education (environmental, scientific, liberal study)
    • Integrated with school curriculum
  • Community and social functions
    • Exercises & hobbies for children, adults & elderly
  • Healing landscape (e.g. horticultural therapy)
    • Sensory, meditation effects; manage emotion/stress
Urban farming on green roofs

Farming on the roof

Vegetables and herbal plants

Watermelon

Green beans

(Photos taken by Dr Sam C M Hui; Acknowledgement: St. Bonaventure Catholic Primary School)
School education green roof projects

(Source: Environment and Conservation Fund)
Urban farming & education

Horticultural therapy & social functions
Sustainable technologies

- Possible integration with greenery to enhance green building performance
  - Rainwater harvesting
  - Renewable energy (e.g. solar photovoltaic & wind)
  - Composting (for producing fertilizer)
- Farming & food production
  - Agricultural green roofs
  - Edible living walls
Green roof research with integrated systems

- Micro-wind turbines
- Rainwater recycling
- Modular system
- Built-in system
- Space for green roof research and urban farming
Integration of green roof, rainwater recycling and renewable energy

屋頂綠化，雨水回收利用和可再生能源的集成
Integration of green roof and solar energy systems

(Source: www.zinco.de)
Integrated solar and extensive green roof

A combination of solar power and green roof: “SolarGreenRoof” secured by a superimposed load.

Solar power plant anchored in the roof substructure without roof greening.

(Source: http://www.optigruen.de/)
Power-Voltage characteristics as a function of PV module temperature

Research on integrated green roof and PV in Hong Kong

PV Panels

Green Roofs

Integrated Green Roof & PV

Upper Roof for Rain Water Harvesting

Wind Turbine

Block 8

Block 9

(Source: Housing Authority, Hong Kong)
Research on integrated green roof and PV in Hong Kong

(Photos taken by Dr Sam C M Hui)
Sustainable rooftop farming 可持續屋頂耕種

- Wind energy 風能
- Greenhouse 溫室
- Composting 堆肥
- Solar energy 太陽能
- Rainwater harvesting 雨水集蓄

(Source: www.skyvegetables.com)
Edible vertical garden 可食用垂直花園

(Source: www.lifeisagarden.com.au)
Useful references


1. Introduction 引言
2. Scope 範圍
3. Definitions 定義
4. Planning Requirements 規劃要求
5. Design Considerations 設計注意事項
6. Construction Methods 施工方法
7. Maintenance Issues 維護問題
8. Project Management 項目管理