Development of Green Roofs for School Buildings in Hong Kong

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Contents

• Introduction
• Types of green roof systems
• Evaluation of their benefits
• Planning and design considerations
• Applications in school buildings
• Potential for environmental education
• Conclusion
Introduction

• Problems that Hong Kong city is now facing
  • Urban heat island
  • Lack of greenery space
  • Stormwater management

• Green roofs can help to mitigate the adverse effects and provide other benefits
  • Bring the nature back to the city
  • Make better use of roof space
Examples of green roofs in Hong Kong

HK Wetland Park

EMSD Headquarters, Kowloon Bay

Parklane, Tsimshatsui

A school in San Po Kwong

(Photos taken by Dr Sam C M Hui)
Types of green roof systems

- Major types of green roofs (see Table 1)
  - Extensive
  - Semi-intensive
  - Intensive
- Roof gardens: usually intensive greening with other features such as potted plants, pond, etc.
- Classify green roof systems by basic design:
  - Built-in green roofs
  - Modular green roofs
Table 1. Major types of green roofs and their characteristics

<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>
</tr>
<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>
</tr>
<tr>
<td>Plant diversity</td>
<td>Low</td>
<td>Greater</td>
<td>Greatest</td>
</tr>
<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
Types of green roof systems

• **Built-in green roofs**
  - Installed in layers for the roof surface
  - More complex and permanent
  - Time needed for on-site installation & growing
  - Excess weight (180 to 450 kg/m²)
  - Complexity of maintenance

• **Modular green roofs**
  - Prefabricated off-site, pre-grown, with modular design
  - Sub-divided into standard interchangeable parts
Types of green roof systems

• Types of modular green roofs
  • **Mat system**
    • Vegetated mat, pre-grown, rolled up and transported
    • Very light weight and thin (45 mm)
  • **Tray system**
    • Most commonly found nowadays
    • Tray containers (e.g. plastic) filled with all elements
  • **Sack system**
    • Sack paks easily conformed to irregular areas
    • Growing medium in fabric module ready for planting
Vegetated mat system (www.elteasygreen.com)

Tray system (www.liveroof.com)

Sack system (www.greenpaks.com)
Evaluation of their benefits

- Major aspects
  - Visual and aesthetic
  - Ecological
  - Local microclimate and thermal
  - Amenity

- Benefits for the community (public)
- Benefits for building owners & users (private)
<table>
<thead>
<tr>
<th>Public benefits:</th>
<th>Private benefits:</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Mitigate urban heat island</td>
<td>- Increase roof life expectancy</td>
</tr>
<tr>
<td>- Reduce dust and pollutant levels</td>
<td>- Reduce noise levels</td>
</tr>
<tr>
<td>- Stormwater retention</td>
<td>- Enhanced thermal insulation</td>
</tr>
<tr>
<td>- Natural habitat for animals/plants</td>
<td>- Heat shield</td>
</tr>
<tr>
<td>- Cities and landscapes</td>
<td>- Better use of space</td>
</tr>
<tr>
<td>- Nature look (aesthetic)</td>
<td>- Reduced risk of glare for surrounding buildings</td>
</tr>
</tbody>
</table>
Evaluation of their benefits

- Other possible benefits of green roofs
  - **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 & education

Horticultural therapy & social functions
Planning and design

- Key factors for planning green roofs
  - Structural loading
  - Accessibility
  - Waterproofing
  - Drainage
  - Maintenance
- Other design considerations
  - Selection of plants (hardy plants, e.g. sedums)
  - Stakeholders’ involvement & support
Planning and design

- Designing green roofs in Hong Kong
  - High-rise buildings have very limited roof area
    - More effective to apply green roof to medium- or low-rise buildings/structures
    - Occupants from surrounding can enjoy the green roof
  - Existing buildings often have constraints on roof structural loading & space
    - Select extremely light-weight green roof systems
    - Inaccessible roof: use extensive green roof
    - Accessible roof: build roof garden or hybrid systems
Planning and design

• Important climatic factors in Hong Kong
  • Typhoons
    • May blow away green roof components & vegetation. Modules & plants must be well secured and protected
  • Heavy rainfalls
    • Stormwater drainage and hygiene (mosquito) issues
  • High temperature – affect some plant species
  • Strong sunlight
    • Solar & UV effects on green roof materials & components
Applications in school buildings

- School buildings in Hong Kong
  - Different designs & ages (some new, some old)
  - Possible roofs for greening:
    - Classroom buildings
    - Assembly halls
    - Covered walkways
- Major limitations & barriers
  - Lack of budget ($$)
  - Lack of knowledge & understanding
  - Accessibility & technical issues (e.g. water leakage fear)
Applications in school buildings

- Some primary school green roof projects (by the Architectural Services Department)

A school in San Po Kwong

A school in Tsang Kwan O
Applications in school buildings

• Our green roof research aims to develop:
  • Knowledge of green roof technology
  • Assessment and design guidelines
  • Practical information for green roof application

• Why we are interested in school buildings?
  • They have good potential for applying green roofs
  • Can demonstrate many benefits & issues
  • Can influence the local community & students
  • Can integrate/serve many education purposes
A green roof project with integrated systems in a primary school

- Micro-wind turbines
- Rainwater recycling
- Modular system
- Built-in system

- Space reserved for green roof research
- Space reserved for urban farming
Environmental education

• School green roof projects
  • Allow school principal, teachers, students, parents, etc. to participate
    • They see, feel & help to maintain the green roof
  • Form part of the learning activities or school curriculum for students
    • Environmental awareness
    • Science education
    • Horticulture
• Provide space & opportunities for other functions
  • Such as urban farming & community activities
Innovative and interesting green roof designs
Environmental education

- Possible learning topics from green roofs
  - Biodiversity
  - Building & roof construction
  - Energy conservation
  - Gardening & horticulture
  - Natural habitat
  - Thermal insulation
  - Urban heat island
  - Water conservation
Infrared photo for assessing thermal effects

Typical hardy plants (sedums) used for green roofs
Conclusions

- Green roofs can provide many benefits to mitigate environmental problems in cities.
- When applied to school buildings, green roofs can achieve both environmental and educational purposes.
- More efforts are needed in Hong Kong to develop design guidelines & practical experience for green roof application.
THANK YOU!!

The green roof volunteers in Hong Kong

(Our green roof research information can be found at: www.hku.hk/bse/greenroof/)