Centre for Urban Greenery & Ecology
CUGE Standards

GUIDELINES ON **DESIGN LOADS FOR ROOFTOP GREENERY**

CS E01:2009

Guidelines on Skyrise Greenery

Published by:
Centre for Urban Greenery & Ecology
National Parks Board HQ
1 Cluny Road
Singapore 259569

CUGE® CENTRE FOR URBAN GREENERY AND ECOLOGY

BCA | NPARKS GREEN MARK FOR PARKS

NATIONAL PARKS

CS E: Skyrise Greenery

CUGE STANDARDS CS E01:2009

GUIDELINES ON **DESIGN LOADS FOR ROOFTOP GREENERY**

Published by:
Centre for Urban Greenary & Ecology
National Parks Board Headquarters
1 Cluny Road
Singapore 259569

The CUGE Standards Series is a set of written guidelines for adoption in the landscape and horticulture industry. They are written through a formal process that involves consultation with relevant bodies and reaching a consensus across all interested parties so that the final document meets the needs of business and industry. All standards take the form of either specifications, methods, vocabularies, codes of practices or guides.

The CUGE Standards Series comprises:

CS A Specifications on properties of planting media
CS B Landscape construction & management
CS C Urban ecology
CS D Landscape design
CS E Skyrise greenery

ISBN 978-981-08-5231-3

Design Loads for Rooftop Greenery
First Edition: CS E01: 2009

The CS E01:2009 was prepared by the CUGE Standards Technical Committee (CS E01:2009). The Technical Committee was represented by:

Mr. Long Seen Hui (National Parks Board)
Mr. Poh Choon Hock (National Parks Board)
Mr. Chew Thiam Kwee (National Parks Board)
Mr. Wong Ngian Chung (Building and Construction Authority)
Ms. Tay Ah Ching (Building and Construction Authority)
Mr. Han Kin Sew (Workplace Safety and Health Council)

The CSE01:2009 was approved by the CUGE Standards Review Panel in DATE.
The CUGE Standards Review Panel was represented by:

Dr. Leong Chee Chiew (National Parks Board)
Mr. P. Teva Raj (National Parks Board)
Mr. Henry Steed (Singapore Landscape Industry Council; Singapore Institute of Landscape Architects)
Mr. Michael Teh (Singapore Landscape Industry Council; Landscape Industry Association Singapore)

The CUGE Standards will be reviewed every three years. Concurrently, we are also gathering information through on-going research.

CONTENTS

Design Loads for Rooftop Greenery

SECTION 1 SCOPE AND GENERAL

1.1 INTRODUCTION

This part of the CUGE Standards Series sets out the basic requirements for the construction of rooftop greenery in respect of design load.

Design load is a critical factor in the determination of the build-up of the rooftop greenery, selection of vegetation and the method of cultivation on rooftop, more so as compared to grade level landscaping.

Unlike landscaping at grade level, the construction of rooftop greenery is biased towards the use of systems and methods that employ lightweight strategies.

The tabulation of all intended loads, must be considered at maximum water capacity and matured vegetation.

1.2 OBJECTIVE

This part of the CUGE Standards Series is intended as a guide for the design, planning and construction of rooftop greenery – namely, green roof and roof garden.

The objective of this part of the CUGE Standards Series is to set out the basic requirements for the topic of design load and its considerations in the making of rooftop greenery – It is intended to act as a common reference point for quality assurance of rooftop greenery.

The design and construction of rooftop greenery shall complement the relevant codes of practice and standards necessary for compliance with relevant authorities.

1.3 DEFINITIONS

Green roof
Green roofs, also known as the extensive green roofs, are in general not designed for public use and are mainly developed for aesthetic and ecological benefits (Scholz-Barth, 2001). They are distinguished by being low cost, lightweight (50-150 kg/m2) and with shallow mineral substrates. Minimal maintenance is required and inspection is performed once or twice a year. Plants selected tend to be of low maintenance and self-generative. Extensive systems can be placed on pitched roofs of up to 30 degrees (Kalzip Nature Roof, 2001) and are common in European countries such as Germany.

Roof garden

Roof gardens, also known as the intensive green roofs, are developed to be accessible for use (Scholz-Barth, 2001). Hence, they usually incorporate areas of paving and seating. The added weight, higher capital cost, intensive planting and higher maintenance requirements characterize intensive green roofs (Peck et al., 1999). The plant selection ranging from ornamental lawn, to shrubs, bushes and trees consequently affects the weight, build-up heights and costs of the roof garden (Zinco, 2000). Further, regular garden maintenance such as mowing, fertilizing, watering, and weeding is required for intensive landscapes.

1.4 PERFORMANCE REQUIREMENT

In the design, planning and construction of rooftop greenery, the combined dead, live, imposed, wind and other intended loads are to be sustained and safely transmitted to the ground, without causing deflection and deformation and impairing the stability of any part of the building.

It is important that owners, tenants and building management are aware of the roof loading restrictions, to avoid future improper relocation or additional plantings in areas not designed to accommodate the additional weight.

Waterproof, thermal-insulation and root-penetration barriers must have adequate compressive strength and point load, if any, must not compromise these barriers.

SECTION 2 LOADING CONDITIONS ON ROOFTOP GREENERY

2.1 LIVE LOADS AND DEAD LOADS

Live loads (dynamic loading associated with roof usage) includes:

- Loads from wind and rain;
- Loads during building/landscape maintenance;
- Loads from the rate of visit by users (The occupant live load imposed – for flat roof accessibility to cater to more than maintenance purpose – shall be 1.5kN per meter square measured on plan, with reference to Building Control Regulations, Cap. 29, Rg 5);
- Surface load due to the vegetation;
- Load of water stored within the integrated reservoir of the rooftop greenery system; and
- Dry and wet weight of growing medium (The typical wet soil weighs approximately 22kN per cubic meter. The soil imposed load varies, dependent on the depth of soil). Please refer to Table 4 for the recommended soil depths for various vegetation types.

Dead loads (Static loading from structure and equipment) includes:

- Point loads generated by permanent bulky structures/equipments/landscape-features; and
- Weight of planter boxes and peripheral structures (For most reinforced concrete, a typical value for the self weight is 24kN per cubic meter. This varies considerably depending on whether the structures are wet or dry).

Waterproof, thermal-insulation and root-penetration barriers must have adequate compressive strength and point load, if any, must not compromise these barriers.

It is important that owners, tenants and building management are aware of the roof loading restrictions, to avoid future improper relocation or additional plantings in areas not designed to accommodate the additional weight. The building shall be able to resist loads determined in accordance with the following requirements of the latest BCA (Building and Construction Authority) Building Control Act and Regulations. Please refer to relevant web-link:
http://www.bca.gov.sg/Publications/BuildingControlAct/others/Approveddoc.pdf

The loading codes should refer to section B.3.2 of BCA Approved Document Acceptable Solutions.

Dead loads :

- Schedule of Weights of Building Materials – BS 648; and
- Loading for Buildings. Code of Practice for Dead and Imposed Loads – BS 6399: Part 1

Imposed roof loads :

- Loading for Buildings. Code of Practice for Imposed Roof Loads – BS 6399: Part 3

Wind loads:

- CP3 Chapter V Part 2
- Loading for Buildings. Code of Practice for wind loads – BS 6399: Part 2

2.2 STRUCTURAL CAPACITY

A structural engineer, who is responsible for the structural design of the supporting roof structure, shall be consulted during the design of any green roof and roof garden.

The maximum load bearing capacity of a roof, as established by the structural engineer, must never be exceeded.

It is important that owners, tenants and building management are aware of the roof loading restrictions, to avoid future improper relocation or additional plantings in areas not designed to accommodate the additional weight.

2.3 MATERIALS

Materials used in the construction of rooftop greenery shall be appropriate for the circumstances in which they are intended.

2.3.1 Landscape Stones

Rock and stone features shall be positioned over structural members, such as columns and beams, wherever possible.

Their collective weight must be considered when tabulating and establishing the total intended load. Large-scale feature rocks will be considered as point loads.

Smaller pebbles and stones must also be of adequate size and weight to avoid being lifted off the roof by strong winds. As such, small aggregates and pebbles are not encouraged along roof edges that are very exposed and/or without additional protection features (such as a parapet wall). Please refer to Table 1 for estimated material weights of soils and other green roof components.

The onus is on the owner and the user to ensure that these landscape materials are not misused. Falling stones and stones thrown off the roof, can pose serious danger to pedestrian at the ground level.

2.3.2 Water Feature

Water features should be positioned over structural members, such as columns and beams, where possible.

Design of water features shall explore minimum usage of water without compromising the visual and spatial delight that a water feature can bring.

2.3.3 Small Trees

Trees grow and increase in weight as they mature. This must be taken into account when establishing the load bearing capacity of the roof.

Bulky vegetations, such as trees and big shrubs, should be positioned over structural members, such as columns, wherever possible.

If the root area of the tree is to be covered with pebbles and small stones, the weight of these additional landscape elements must be considered when tabulating the total intended load.

The saturated weight of the soil medium must be considered.
Please refer to Table 2 for estimates on plant weights of various vegetation types.

2.3.4 Paving

Strong and durable paving selection is preferred.

Trafficable paving shall be appropriately anchored to the roof structure.

Paving that is not structurally anchored should be of sufficient weight to avoid being uplifted by strong wind. (Please refer to section 2.4 on wind load)

Ornamental stone paving can be used much like landscape rocks.

2.3.5 Growth medium

The vegetation growth medium on a roof should be lightweight, without compromising the primary functions of the medium (such as in providing anchorage for the plant roots, water and nutrients to the plants), with consideration for the structural limitations of the roof and its supports.

In general, green roof uses lightweight shallow growth medium while roof garden, may involve a broader range of vegetation selection requiring varying depths of growth medium. Increase in depth of growth medium equates increase in overall loading. Please refer to Table 4 on the recommended soil depths for various vegetation species.

As the depth and eventual weight of the growth medium is primarily determined by the selection of plants and the overall design concept, it is advisable to seek a rooftop landscape specialist to establish the overall intended load.

The saturated weight of the growth medium must be considered.

The optimal depth of growth medium shall be used for the intended vegetations, avoiding excessive weight on the roof. Please refer to figures 1, 2 & 3 for examples on alternative ways to reduce weight of planting medium.

2.3.6 Rainwater Harvesting System

Should rainwater-harvesting technique be employed in the design of the green roof or roof garden, it must be designed in relation to the structural limitations and requirements of the roof and its supports, with consideration for the weight of the water collected during optimal capacity.

Should the rainwater harvesting be incorporated as an integral part of the building structure, it must be in accordance with the requirements of the latest BCA (Building and Construction Authority) Building Control Act and Regulations. Please refer to relevant web-link:
http://www.bca.gov.sg/Publications/BuildingControlAct/others/Approveddoc.pdf

Rainwater harvesting while beneficial, should not compromise on public health standard. The rainwater harvesting system has to be designed and constructed in accordance with the latest NEA (National Environment Agency) requirements.

2.3.7 Selection of Vegetation

Green roof, with its shallow lightweight growth medium supports a smaller range of suitable vegetation species, consisting mainly of lawns, ground covers and small shrubs.

Roof garden, with its deeper growth medium, possibly of varying depths, can support a wide range of vegetation species, from lush ground covers to big shrubs and trees.

Large trees on a rooftop may require more maintenance and lack of maintenance may compromise on safety. Please refer to Figures 4 & 5 for examples of tree planting on rooftop greenery.

In the design and planning of both green roofs and roof gardens, the mature weight of the selected vegetation must be considered. Please refer to Table 2 for estimates on plant weights of various vegetation types.

Vegetation growth should not compromise the performance requirements of the waterproof barrier and the structural integrity of the rooftop.

Vegetation with invasive roots is not encouraged on rooftop greenery. It is advisable to engage and consult suitably qualified and experienced professionals and experts for the selection of vegetation.

2.3.8 Rooftop Landscape Structure/ Features

Rooftop furniture shall be sufficiently heavy, or secured to avoid being easily moved by strong winds and/or other external forces.

Should the roof garden involve erection of natural/composite timber structures, the design shall be in accordance with the requirements of the latest URA (Urban Redevelopment Authority) and BCA (Building & Construction Authority) Building Control Act and Regulations. The following Standards have to be complied with :–

The design of building structures (concrete, steel, aluminium, timber..etc) shall be in accordance with B3.3 of BCA Approved Document Acceptable Solutions.

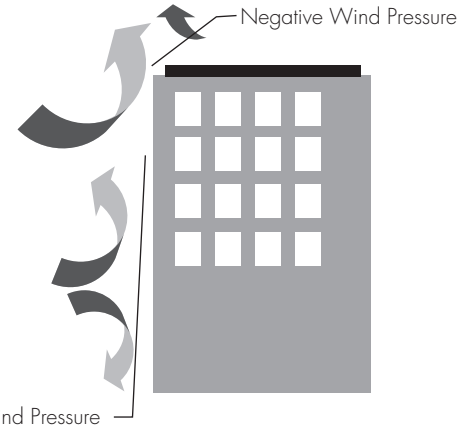
- Code of Practice for Structural Use of Timber – SS CP 7; and
- Structure use of timber – BS 5268-2 – For use of Glued Laminated Timber structures and non-tropical timber.
- Structural Use of Aluminium – BS 8118.
- Structural Use of Steelwork in Building – BS 5950; and
- Design Guide on Use of Alternative Steel Materials to BS 5950 – BC 1

2.4 WIND LOADS

On green roofs, strong winds may generate both positive and negative pressures on the lightweight growth medium. The edges and the corners are vulnerable. Measures must be taken to secure the rooftop greenery system against being uplifted by strong winds.

Positive wind pressure is the force exerted by the wind as it strikes an object, or building. The moving of objects or the bending over of a plant / tree in a strong wind, etc., are evident of positive wind pressure.

Negative wind pressure occurs when wind is redirected and accelerated as the wind passes over an object, creating a pressure differential. This can, in some instances, be substantial.



Paving slab selection of appropriate weight can be used to ensure that the lightweight growth medium stay in place. Should pebbles or stones be used instead, these have to be of appropriate size and weight to avoid being lifted off the roof by strong winds.

During construction, temporary safety measures must be taken to secure anything laid on the roof against being uplifted by strong wind.

On roof gardens, trees must be appropriately anchored to withstand lateral load generated by strong winds and to avoid being uprooted in the process. Additional wind loading results from the horizontal force of the wind being transferred to the roots of the tree, resulting in a downward pressure on one side and an upward pressure on the other side. This is best suited for suitably qualified engineers and landscape experts to determine. In the above-mentioned scenario, the loadings on of these supports must be properly transferred and included in the structural calculations. Tree support and anchorage systems may become exceedingly heavy with larger trees.

The architecture of the building may also cause the tunneling of wind, creating strong gust of moving air that may adversely affect the plants and plant growth. It is to be noted that general wind speed increases with altitude and it is therefore important that this factor of excessive strong wind currents is given due consideration in the design and plant selection for the rooftop greenery. The building shall be able to resist loads determined in accordance with the following requirements of the latest BCA (Building and Construction Authority) Building Control Act and Regulations. Please refer to relevant web-link:
http://www.bca.gov.sg/Publications/BuildingControlAct/others/Approveddoc.pdf

- Code of Basic Data for the Design of Buildings. Loading. Wind Loads – CP 3 Chapter V Part 2, using 33m/s as the basic wind speed (3 second gust speed); and
- Loading for buildings. Code of Practice for Wind Loads – BS 6399:Part 2, using 22m/s as the basic wind speed (hourly mean speed).

The list of tree species suitable for rooftop gardens is available at the following web-link:
http://research.cuge.com.sg/images/stories/handbooks/11._appendix_i.pdf

2.5 EXISTING ROOF

Often in the case of greening an existing roof, the weight of the rooftop greenery system and the intended vegetation is a major consideration, due to the load-bearing limitations of the existing roof and its supports. As such, green roof, which is relatively lightweight in comparison to a roof garden, is usually more appropriate.

Before the design and construction of rooftop greenery on an existing roof, the following must be evaluated:

- The load-bearing capacity of the existing roof;
- The intended function of the rooftop greenery;
- The extent of landscaping possible; and
- The anticipated human load (either for maintenance, visit by user, or both).

Heavy landscape components should be positioned over structural components like columns and beams, to reduce mid-span stresses.

Additional structural elements can appropriately increase structural strength of building.

The installation of safety anchor-points for the anchoring of maintenance safety harnesses/ restraint belts must be coordinated with the loading capacity of the anchoring structure.

2.6 NEW ROOF

In the case of greening a new roof, the roof structure can be designed to accommodate the intended loads of the rooftop. Both extensive green roofs and intensive roof gardens are thus possibilities on a new roof.

Unlike an existing roof, the intended loads of the rooftop greenery on a new roof can be accommodated. Thus, roof gardens are commonly installed on new buildings.

If the roof garden involves planting of trees, the load capacity of the tree anchors must be coordinated with the design of the building's structures.

Anchors for maintenance safety harnesses/restraint belts must be coordinated with structural requirements.

2.7 SLOPED ROOF

In the greening of a rooftop, the pitch of a roof pitch may interfere with the structural and vegetation requirements.

As the gradient increases, water runs off faster from the roof. Retention of water in sloped medium may be more challenging, and may require more irrigation than green roof with gentle slope.

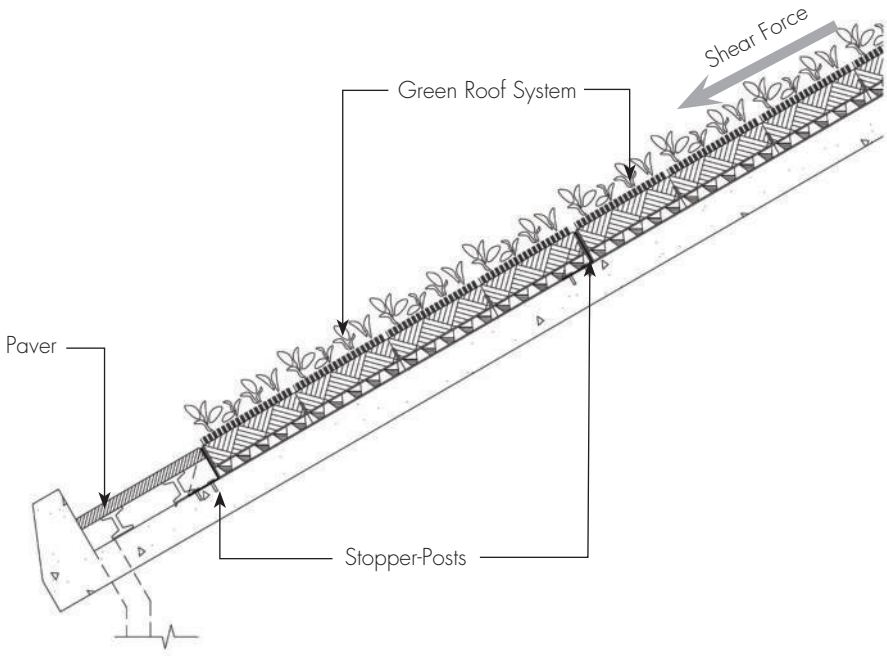
On a sloped roof, the green roof will also experience shear force. The steeper the roof pitch and the greater the extent of green-roof surface, the more significant is the shear force. Mechanism should be put in place to prevent movement of medium and vegetation. The mechanism is dependent on the type of medium and gradient of slope. Tray and fixed modular systems should be considered where the slope gets steeper.

Measures must be in place to ensure the substrate and the vegetation are adequately secured. The shear force between the green roof system and the roof structural surface must be appropriately and safely transferred to the ground. It may be necessary to distribute the load and avoid all the loads from exerting directly onto the parapet on the lower side of the sloped roof. (This may involve the incorporation of stopper-posts)

The parapet of the lower side of the roof has to be designed and constructed with adequate structural capacity and integrity to resist the established shear force. The performance of the root penetration barrier and waterproofing membrane should not be compromised.

Consultation with experts is advised to ensure adequate irrigation and anchorage to substrate and vegetation. Professional Engineer must be consulted to establish the proper transfer of loads to the ground.

The choice of vegetation should also be appropriate.



DISCLAIMER

Note: The relevant listed code of practice and standards are not exhaustive. It is necessary to check with relevant authorities on specific requirements for approval.

Table 1: Estimated Material Weights of Soils and Other Green Roof Components
(Adopted from Study on Greenroof Application in Hong Kong)

MATERIALS WEIGHT (Saturated weight where applicable) – X 100 for kg/m cube	**WEIGHT OF 1CM LAYER** (kg/m sq)	**MATERIALS WEIGHT** (Saturated weight where applicable) – X 100 for kg/m cube	**WEIGHT OF 1CM LAYER** (kg/m sq)
Other Materials		Soil Substrate	
Stone	23–30	Gravel	16–19
Granite	26.6	Pebbles	19
Concrete (precast)	21	Pumice	6.5
Concrete (reinforced)	24	Sand	18–22
Concrete (lightweight)	13–16	Crushed Brick	10–13
Brick (solid with mortar)	18	Sand and gravel mix	18
Hardwood timber	7.3	Topsoil	17–20
Softwood timber	5.7	Topsoil (lightweight)	14
Cast Iron	71	Water	10
Steel	78	Lava	8
Aluminum	27	Rockwool	(1.7 dry) 10
Extruded Polystyrene fill	0.7		

Note: the mixing of particles of different size tend to make moisture capacities and final weights unpredictable.

The above values are estimates. It is advisable to consult Professional Engineer and Landscape experts for the calculation of loads. (The calculation of loads should appropriately take into account the weight of water.)

Table 2: Design loads of the vegetation
(Adapted from the FLL Guidelines for the Planning, Construction and Maintenance of Green Roofing – Green Roofing Guidelines, Germany, 2008 English edition)

FORM OF VEGETATION	DESIGN LOADS in KN/m²	in Kg/m²
Green Roof		
Sedum-herbaceous-grass greening	0.10	10.2
Grass-herbaceous greening	0.10	10.2
Simple roof garden		
Grass-herbaceous greening (grass roof)	0.15	15.3
Wild perennial-shrub greening	0.10	10.2
Shrub-perennial greening	0.15	15.3
Shrub greening (up to 150 cm)	0.20	20.4
Roof Garden		
Lawn	0.05	5.1
Low perennials and shrubs	0.10	10.2
Perennials and shrubs over 150 cm	0.20	20.4
Bushes up to 3 m	0.30	30.6
Small tree[1)] up to 6 m	0.40	40.8
Medium size tree[1)] up to 10 m	0.60	61.2

[1)] Figures relate to measurement taken vertically from ground level to the top of the crown.
Figures are indicative. Structural engineer should be consulted during the design of the green roof and/or roof garden

Table 3: Design loads and water storage of vegetation support layers at maximum water capacity
(Adapted from the FLL Guidelines for the Planning, Construction and Maintenance of Green Roofing – Green Roofing Guidelines, Germany, 2008 English edition)

SUBSTRATE GROUP SUBSTRATE TYPE	LOAD PER CM COURSE DEPTH in KN/m²	in Kg/m²	MEAN WATER STORAGE PER CM COURSE DEPTH in l/m²
Substrate for roof garden			
Soil/mineral material mixtures	0.16–0.19	16.3–19.4	3.0
Soil/foam* material mixtures	0.13–0.15	13.3–15.3	2.5
Soil/organic material mixtures	0.15–0.17	15.3–17.3	3.5
Peat/mineral material mixtures	0.11–0.12	11.2–12.2	7.5
Compost/mineral material mixtures	0.11–0.13	11.2–13.3	6.5

Table 3 (CONT'D)

Substrate for green roof			
Lava mixtures	0.145–0.165	14.8–16.8	4.4
Lava/pumice mixtures	0.125–0.130	12.8–13.3	4.2
Lava/pumice/dolomite mixtures	0.145–0.165	14.8–16.8	3.9
Lava/pumice/tuff mixtures	0.145–0.165	14.8–16.8	4.7
Sand/lava mixtures	0.160–0.175	16.3–17.9	5.0
Expanded clay mixtures	0.100–0.130	10.2–13.3	4.9
Expanded slate mixtures	0.110–0.130	11.2–13.3	4.9
Mixture of crushed brick chippings	0.130–0.160	13.3–16.3	3.9

* Foam herein refers to expanded polystyrene granules, perlite, vermiculite, etc.

Table 4: Recommended Soil Depths

PLANTING	**RECOMMENDED SOIL DEPTHS***
Green Roof	
Sedum-Herbaceous-Grass greening	60–150 mm (depending on the green roof system)
Roof Garden	
Lawns	100–300 mm
Flowers and Ground cover	150–300 mm
Shrubs	300–600 mm (t)
Small trees	600–1000 mm
Medium trees	1000–1500 mm

* on filter blanket and drainage medium
(t) Depending on ultimate shrub size

The above are recommended soil depths. It is to be noted that there may be exceptional cases (for example, shallower soil depth for specific vegetation, etc.). Such cases should take into considerations the long-term viability of the rooftop greenery system and the vegetation survival rate.

For the list of suitable plants for cultivation on rooftop, please refer to the following publications:

- A Selection of Plants for Green Roofs in Singapore (2nd edition); and
- Handbook on Skyrise Greening in Singapore

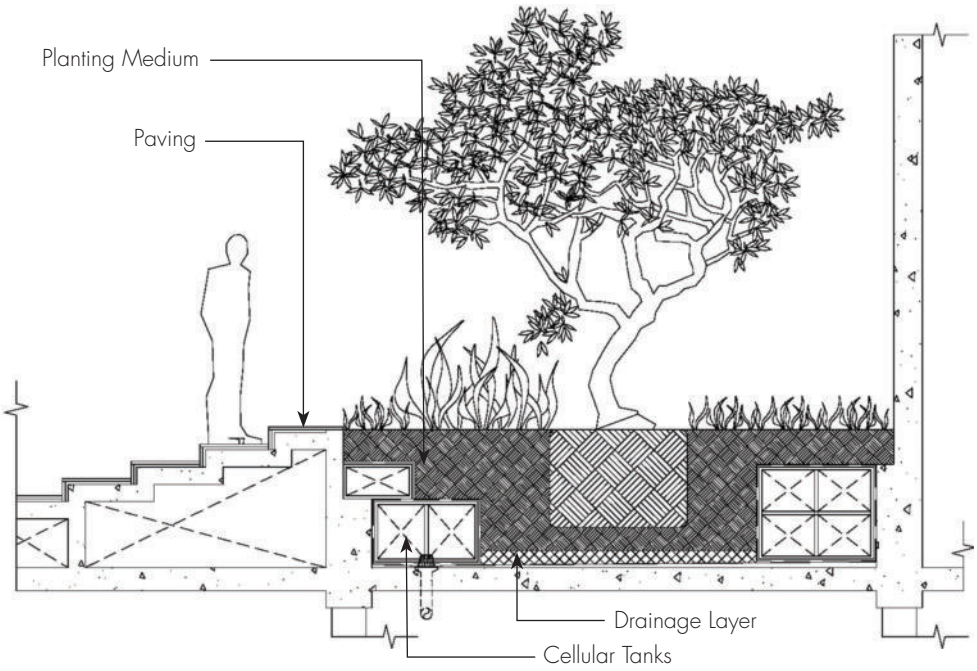


Figure 1
Lightweight cellular tanks are used to raise beds to achieve the required depths of the planting medium. Appropriate use of cellular tanks can help in weight reduction. (The above is a retrofit scenario. For new roof, the proper structural loading should be catered for.)

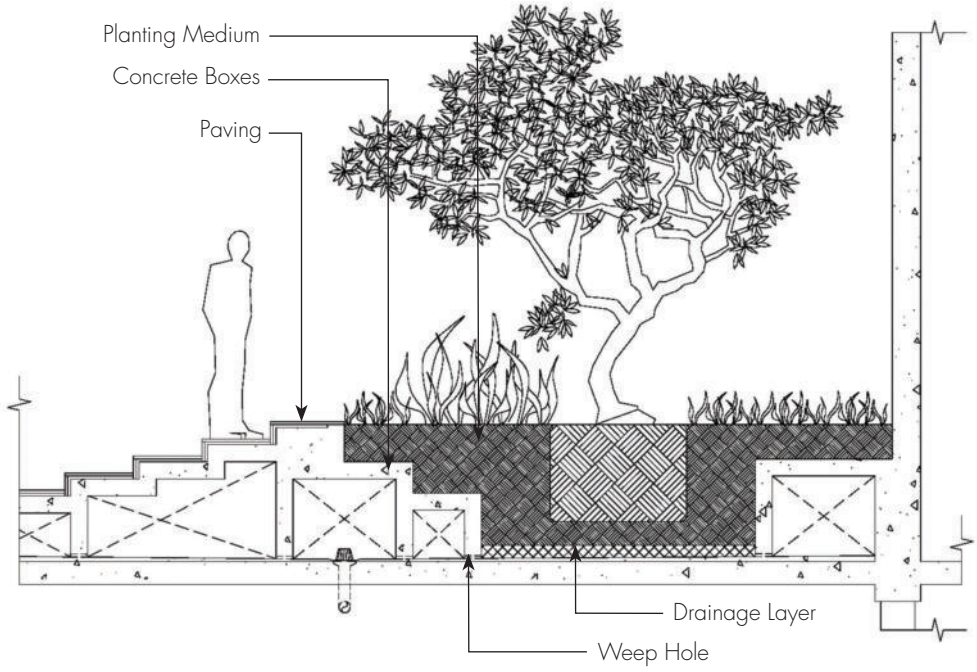


Figure 2
Concrete boxes used to raise beds. Concrete boxes, instead of soil or cellular tanks, are used for lightweight structural strength.

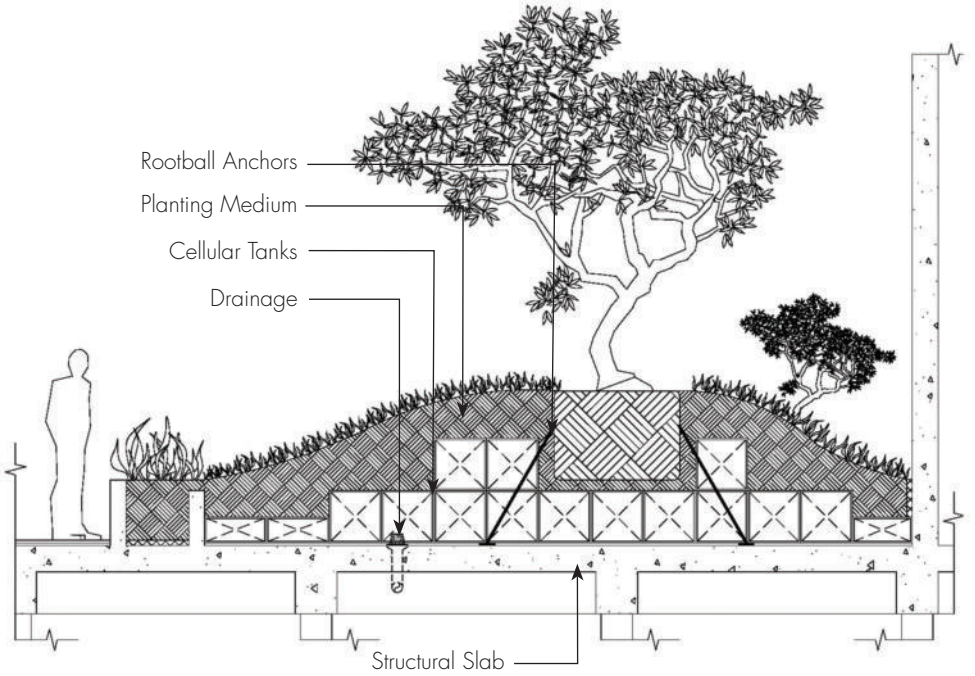


Figure 3
Cellular tanks placed at suitable depths reduce the weight and mass of the planting medium. Figures 1,2&3 are adapted from Time-Saver Standards for Landscape Architecture (second edition) 1998

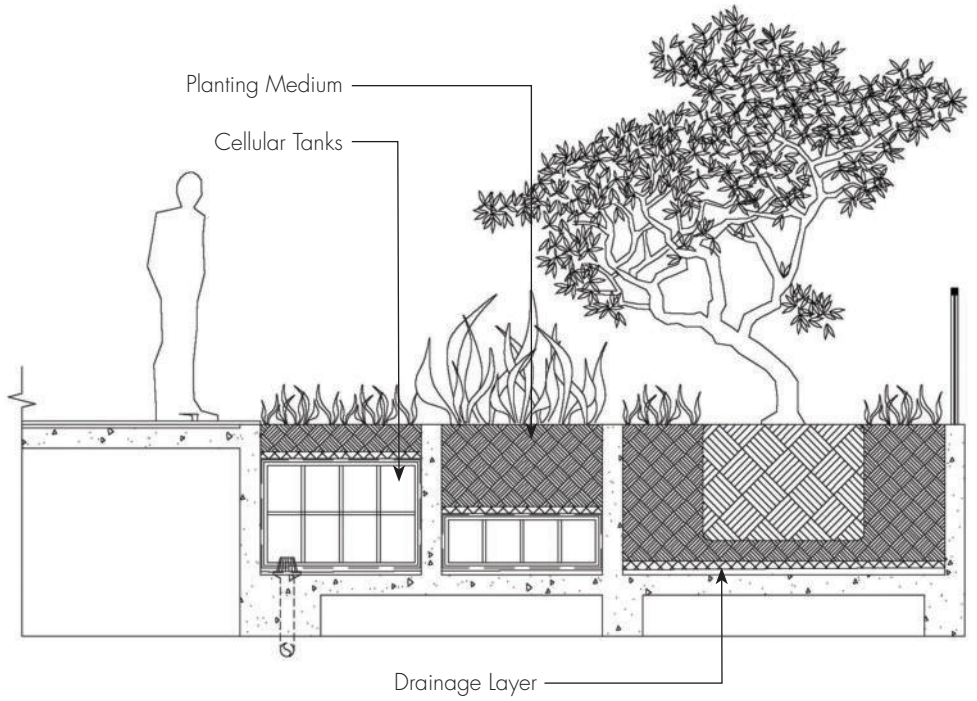


Figure 4
The sunken planters keep the landscape flushed with the rooftop deck. Lightweight cellular tanks are incorporated for weight reduction.

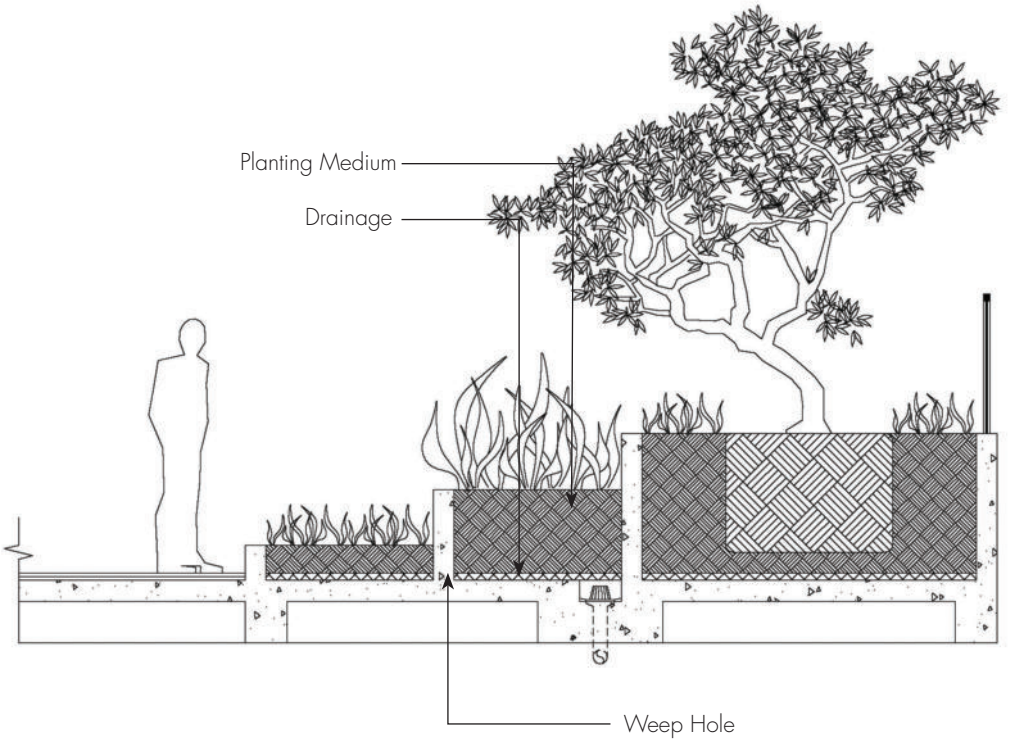


Figure 5
The raised planters can potentially be incorporated as part of the designed landscape terrain of the roof garden.

REFERENCE STANDARDS

BS 6399	Loading for Buildings
BS 8007	Design of concrete structures for retaining aqueous liquids
BS 8110	Structural Use of Concrete
BS 5950	Structural Use of Steelwork in Building
BS 8118	Structural Use of Aluminium
BS 5075	Concrete Admixtures
BS 1881	Methods of Testing Concrete
BS 6089	Assessment of Concrete Strength in Existing Structures
BS 4483	Steel Fabric for the Reinforcement of Concrete
SS CP 65	Structural Use of Concrete
SS CP 7	Structural Use of Timber
SS CP 81	Precast Concrete Slab and Wall Panel
SS CP 82	Code of Practice for Waterproofing of reinforced concrete buildings
SS CP 3	Code of basic data for the design of buildings
	The Building Control Act

About the National Parks Board and Centre for Urban Greenery & Ecology

The National Parks Board (NParks) is responsible for providing and enhancing greenery of the Garden City of Singapore. Beyond managing public parks, the park connector network, lush roadside greenery, nature areas and nature reserves, NParks is committed to enhance the quality of life through creating memorable recreational experiences and lifestyles.

The Centre for Urban Greenery and Ecology (CUGE) is an initiative of NParks. Through its research and training programs, NParks advances knowledge and expertise in urban greenery and ecology in the landscape and horticulture industry in Singapore. It works closely with industry partners to promote good work practices and create a thriving, creative, innovative and professional industry that will support Singapore's aspiration to be a City in a Garden.