SAFE PRACTICES FOR VERTICAL GREENERY



This document consists of inputs from the following agencies:

Building and Construction Authority (BCA), Housing and Development Board (HDB), Ministry of Manpower (MOM), National Environment Agency (NEA), National Parks Board (NParks), Public Utilities Board (PUB) and Singapore Civil Defence Force (SCDF).



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REFERENCES



This list of "Essential Considerations" is complementary to the "Explanatory Note" that follows. Please refer to the "Explanatory Note" for more detailed information on Safe Practices for Vertical Greenery.

BEFORE INSTALLATION OF VERTICAL GREENERY

Structural Considerations

- Engage a Professional Engineer (PE) to certify that the structural elements can support the proposed vertical greenery loads and that the vertical greenery system(s) and its corresponding anchorage and fixings are safely secured. Where necessary, PE is to advise appropriate structural strengthening, with compliance to the Building and Construction Authority's (BCA) requirements.
- The vertical greenery system(s) must not cover structural elements to allow for easy periodic inspection, where applicable.
- Avoid direct contact of plant roots with the building's structural elements, such as columns and beams, etc. Root barrier membranes can be considered.
- Provide an adequate lightning protection system if the vertical greenery is located at a height on a building and/or structure.

Design Considerations

- Cater for safe maintenance and operations access. Safety and maintenance concerns should be addressed early during the design stage.
- When selecting plants and materials, consider the extent and frequency of maintenance work required and the corresponding costs.
- Provide effective drainage, including the convenient discharge of excess water and clearing of runoff media, plant materials, leaf litter, etc. Avoid water stagnation.

Technical Considerations

Avoid compromising the aggregate area of the openings of the facades of naturally-ventilated buildings.

Consider fire safety requirements and consult the Singapore Civil Defence Force (SCDF) if necessary.

DURING THE INSTALLATION OF VERTICAL GREENERY

Safety is the top priority. Be aware of work hazards, including those leading to falls from heights and falling objects.

Ensure appropriate and safe work schedules, sequences, equipments and work-methods are adhered to, with adequate site supervision. While working on site, workers of all trades are to remain alert for hazards, not only for their own safety, but also on behalf of their colleagues and create a safe work environment for all.

AFTER THE INSTALLATION OF VERTICAL GREENERY

Ensure a regular maintenance schedule is conducted by qualified workers. Look out for potential risks, hazards and problems.

Periodically inspect supporting structures of the vertical greenery, such as connections to walls/panels, for signs of corrosion, loosening, defects, etc. Ensure structural integrity is maintained.

Ensure efficient discharge of water into and within the drains.

Conduct routine inspection to check for any structural defects, which may result in stagnant water and hence mosquito-breeding habitats, or create rodent-breeding habitats.

Site risk assessment should be conducted prior to maintenance work to ascertain any potential risks, hazards and problems. Devise respective countermeasures.

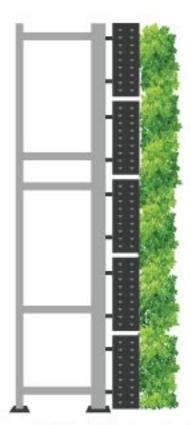


DUTIES OF THE BUILDING OWNER

- Building owners are responsible for the installation, maintenance and safety of their vertical greenery, unless another stakeholder is officially appointed (e.g. a Qualified Person (QP) during construction).
- Safety features (e.g. maintenance access, anchorage points, safety lines, Personal Protective Equipment (PPE), etc.) should be part of the design requirements in view of future maintenance operations.
- Recognised professionals should be engaged to perform relevant checks and certifications where necessary.
- Building owners should verify that the engaged design, installation and maintenance teams fulfill their responsibilities, which are inclusive of but not limited to those listed below.

DUTIES OF THE PROFESSIONAL ENGINEER

Structural Integrity



The engaged PE should check and certify the adequacy of structural elements, bracings and attachments to carry the vertical greenery load.

- The engaged PE should check and certify the adequacy of structural elements (i.e. beams, columns and reinforced concrete walls) to support the loads from the vertical greenery systems. The weight of mature and saturated vertical greenery systems should be considered.
- If the existing structural elements are able to accommodate the additional loads from the vertical greenery, a copy of the PE's design calculation and certification must be given to the building owner. This document should be submitted to the relevant PE and BCA when the building is due for periodic structural inspection.
- If strengthening of structural elements is required, the PE should submit the structural plans and design calculations to BCA for approval.
- The installed vertical greenery panels must be secured. The designed structure, its attachment/ anchorage onto the structural elements and other details must be certified by the PE and submitted to BCA for approval.
- Structural elements should not be covered by the vertical greenery system; they should be exposed for the purpose of periodic structural inspection.
- Where possible, direct contact of plant roots with the building's structural elements should be avoided. Exceptions can be made where this is intended and appropriately provided for in the design and construction of the building that will not compromise the building's future structural integrity. Consider root barrier membranes.

Lightning Protection

- Engage a Professional Electrical Engineer to ensure that a lightning protection system is adequately designed and fitted to protect people and the vertical greenery system from the effects of lightning strikes.
- The lighting protection system should be designed and installed in accordance with the Approved Document by BCA.

DUTIES OF THE DESIGNER

Plant and Material Selection



Plants and materials should be carefully chosen to suit the environment and the preferred maintenance regime.

- The extent and frequency of maintenance work required should be considered in the design of the vertical greenery. Cyclical plant and component replacement and routine maintenance costs should be taken into consideration during design stage.
- Choose plants that are suitable for the site and microclimate. Where possible, select materials that require less frequent maintenance and plants that are more drought- and disease-tolerant. In areas with strong wind, drought-tolerant plants can be considered. Where maintenance cost is a concern, plants chosen should be slower-growing and require minimal pruning.

Drainage System



Effective drainage systems should be catered in the design of vertical greenery systems.

- Have adequate drainage capacity (in terms of outlet capacity, number of outlets, placement of outlets, etc.)
- The drainage systems should effectively convey water to the storm water drainage system at ground level.
- For new developments greater than or equal to 0.2ha
 in size, vertical greenery should be used together with
 other stormwater detention and retention features to
 control the peak runoff discharged from the
 development site. For a design storm with a return
 period of 10 years and for various storm durations of
 up to 4 hours (inclusive), the maximum allowable peak
 runoff to be discharged to the public drains should be
 calculated using the Rational Formula, with a runoff
 coefficient of 0.55.
- Stormwater that is detained should be released into public drainage systems only when the water in the downstream watercourses have dropped below 75% of the drain depth.
- The Rational Formula for computation of peak runoff and intensity-duration-frequency curves describing the rainfall intensity that the stormwater drainage system is supposed to be designed for can be found in PUB's Code of Practice on Surface Water Drainage.

Design for Maintenance Access



Cat ladders and sufficient space behind vertical greenery structures allow workers to effectively access the system for maintenance.



Gondola attachment structures allow for maintenance of vertical greenery that span several levels.

- Safe and easy maintenance access should be provided for early in the design stage. Workers should be able to reach and manoeuvre around the work area effectively to thoroughly inspect and maintain the vegetation and/or system.
- Plan for the provision of suitable access to and from the work area and take into account the tools and equipment that the workers will need to carry during maintenance.
- Means of access (tower scaffold, ladders etc.)
 must be structurally sound, stable, of adequate
 strength for the intended purpose and must
 comply with the Work Safety and Health
 Council's (WSHC) Work-At-Height (WAH)
 requirements.
- In cases where vertical greenery systems span a few storeys, maintenance access should be provided at every level.

Maintenance Cost

- Design and plant prudently to ensure ease of maintenance.
- Bear in mind that maintenance costs include routine maintenance and cyclical plant and component replacement costs.
- If low maintenance is preferred, proposed plants should require minimal pruning, be slow growing and hardy.
- The design of the vertical greenery should ideally meet the maintenance expectations of the building owner and/or building operator.

Fire Safety Requirements

- The installed vertical greenery must not impede the building's fire safety provisions, strategies and performances.
- The SCDF will review the requirements for vertical greenery on the merits of each case.
- For example, SCDF would not allow vertical greenery installations if the proposed designs
 affect smoke ventilation or cause fire and smoke to spread to upper floors and essential spaces
 such as naturally-ventilated exit staircases, smoke stop or fire-fighting lobbies, etc.

Other Requirements

- The following authorities should be consulted and furnished with necessary submissions before commencement of work:
 - Building and Construction Authority (BCA)
 - Housing and Development Board (HDB)
 - National Environment Agency (NEA)
 - National Parks Board (NParks)
 - Public Utilities Board (PUB)
 - Urban Redevelopment Authority (URA)
 - Other relevant authorities

DUTIES OF THE LANDSCAPE CONTRACTOR

Drainage

- Drainage systems for vertical greenery should be adequately designed with proper gradients to prevent water stagnation and mosquito breeding.
- Lightweight drain covers, inspection chambers and/or drainage outlets of larger sizes should be used to facilitate maintenance and regular cleansing.
- · Where the installation of roof gutters is necessary, the QP has to apply to NEA for a waiver.

Work Safety



Where scaffolding is used, it must be properly erected based on requirements under the Workplace Safety and Health (Scaffolds) Regulations. Workers working on scaffolds should wear the appropriate PPE and be provided with proper anchorage where necessary.

- Ensure that appropriate and safe work procedures, schedules, equipments and work-methods are adhered to, with adequate site supervision.
- Risk assessments should be conducted prior to maintenance work to ascertain any potential risks, hazards and problems, in particular, the risk of falling from heights and falling objects. Respective countermeasures should be devised.
- Measures to safeguard against falling from height should include, but are not limited to the following:
 - Providing safe means of access to or from a work area
 - A work platform with adequate barricades and secured anchorages
 - The appropriate full body harness and travel restraint or fall arrestor when working from the bucket of an aerial lift and/or from any elevated work space
- Ensure adequate site supervision is provided and that all workers understand and comply with the established safe work procedures, safety rules and work methods, including proper usage of all personal protective equipment (PPE) provided.
- For lifting operations involving cranes (including lorry cranes), measures such as the Lifting Plan, Permit-to-Work (PTW) system and Risk Assessment (RA) should be implemented to address lifting-related hazards. These hazards include getting struck by a falling or swinging load, collapse of crane and nearby vehicular traffic.

DUTIES OF THE MAINTENANCE TEAM

Regular Maintenance

- · A regular maintenance schedule should be in place.
- Maintenance should include identifying potential risk, hazards and problems, replacement and maintenance of the greenery present. The supporting structure for the vertical greenery, such as connections to walls/panels, should also be inspected for signs of loosening and metal corrosion.
- Silt, sediment, plant debris and litter should be cleared so that they do not compromise the drainage and rooftop detention systems. Efficient discharge of water should be ensured.
- Structures should be checked for defects, which may result in stagnant water and create
 potential mosquito-breeding habitats. Bacillus thuringiensis israelensis (BTI) should be applied
 in potential breeding habitats when necessary. BTI is a biological control larvicide that destroys
 mosquito larvae in stagnant water.

Ventilation



For naturally; ventilated buildings, the vertical greenery should not compromise the aggregate of the openings required.

- For naturally-ventilated buildings, provision of vertical greenery at the façades should not compromise the aggregate area of the openings required.
- The vertical greenery should not compromise the performance of any mechanical and electrical systems that may be installed on building facades, such as ventilation outlets and inlets.

Work Safety

Please refer to the section "Work Safety" under "Duties of the Landscape Contractor".

REFERENCES

- · A Concise Guide on Vertical Greenery
- Approved Document (by BCA)
- Code of Practice on Surface Water Drainage (by PUB)
- DC Handbook For Residential Developments (by URA)

For more information on safe working conditions at heights and safe lifting operations, please refer to:

- · Approved Code of Practice for Working Safely at Heights
- Code of Practice on Safe Lifting Operations in the Workplaces
- Ladder Safety Pack
- Lifting Equipment Technical Advisory
- Workplace Safety and Health (General Provisions) Regulations
- Workplace Safety and Health (Scaffolds) Regulations
- Workplace Safety and Health (Work at Heights) Regulations
- Workplace Safety and Health Guidelines Anchorage, Lifelines and Temporary Edge Protection Systems
- Workplace Safety and Health Guidelines Personal Protective Equipment for Working at Heights
- Workplace Safety and Health Guidelines Safeguarding against Falling Objects
- Workplace Safety and Health Guidelines Working Safely on Roofs

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