NUS-IES Design for Safety (DfS) Library 2026
Substructure, Bridges, Building Envelope, Electrical System, and Landscaping

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Authors:
NUS Safety and Resilience Research Unit (SaRRU): Prof. Goh Yang Miang, Ms. Du Shuang, Ms. Olivia Hu Yueqi

Institution of Engineers, Singapore (IES): Mr. Hoe Yee Pin, Er. Ng Lee Chian, Mr. Jason Oh, Mr. Jonathan Tan, Mr. Tan Kay Chen, Er. Steve Yeung

Other Contributors:

Mr. Sunny Teo
Er. Ng Teck Eng
Er. Ling Shiang Yun

Disclaimer

i. The information presented below is for consideration, and not the official guide for Design for Safety, as the actual needs may vary between projects.
ii. Ultimately, the Designers need to assimilate this information with their experience and skill to develop their own approach.
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Note:

"Design risk", in relation to a structure, means anything present or absent in the design of the structure that increases the likelihood that an affected person will suffer bodily injury when constructing, working at, or demolishing the structure (WSH (Design for Safety) Regulations, 2015).

"Hazard" means anything with the potential to cause bodily injury, and includes any physical, chemical, biological, mechanical, electrical or ergonomic hazard. (WSH (Risk Management) Regulations, 2006)

"Hazard" is therefore the broader concept. This DfS library focuses specifically on design risks arising from the design of a structure, as illustrated below.



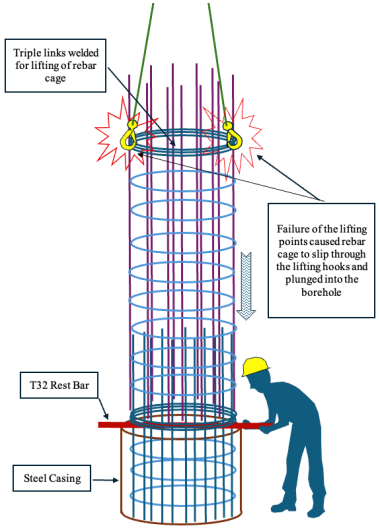
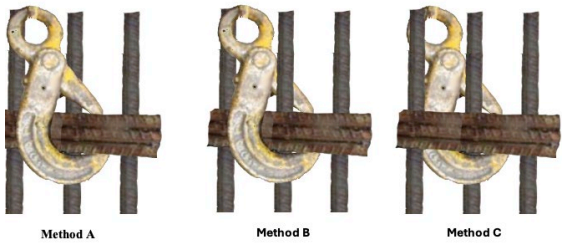
This DfS library focuses on controls that designers can incorporate or influence. These generally address the higher levels of the hierarchy of control: elimination, substitution and engineering controls. The design of personal fall-protection systems is also treated as a design-related control where such systems are necessary and a designer is directly involved. Administrative controls are used to communicate the residual risks to downstream stakeholders.

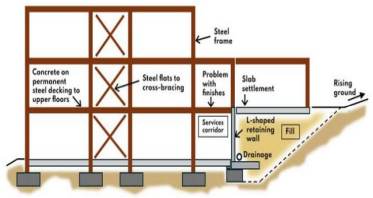
Abbreviations: A&A – additions and alterations; C&S – civil and structural; DfM – Design for Maintainability; FM – facilities management; M&E – mechanical and electrical; MEWP – mobile elevating work platform; PPE – personal protective equipment; SLD – single-line diagram; LOTO – lockout/tagout; BIM – building information modelling; SWP – safe work procedure; FFH – fall from height; SRL – self-retracting lifeline; FBH – full-body harness.

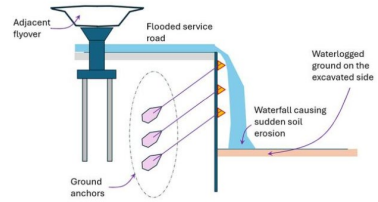
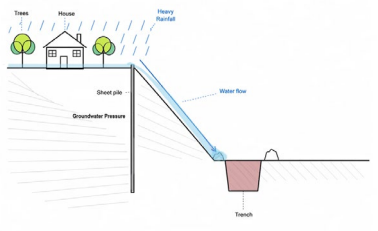
Contents

1 Substructure 4
2 Bridges 7
3 Building Envelope 12
4 Electrical System 19
5 Landscaping 22
6 Case Study 33
6.1 Landscaping Case Study – The Green Cascade Pickleball Court 33
6.1.1 Design Concept 33
6.1.2 Design Risks and Possible Design Changes 34
6.1.3 Other Considerations 36
7 References 37

1 Substructure

#	Component & Case Details	Design Risk	Proposed DfS Control Measure(s)	Relevant Stakeholder	References
1	Rebar cage of RC bored pile dislodged during lifting  Case ID: SUB-001. Activity: Cage lifting. Design stage: Detailed design / pre-construction.	**Risk 1 – Ambiguous lifting-point geometry during rigging** The lifting-link geometry permits alternative hook positions, including attachment to vertical rebars. During lifting, an unintended load path can cause the cage to dislodge or collapse and strike workers nearby.  **Risk 2 – Manual support removal within the collapse zone** The temporary rest-bar arrangement requires workers to remove supports beneath or beside the suspended cage, exposing them to crushing or being struck if the cage or lifting arrangement fails.	**Elimination of close-proximity support removal** Design the temporary support arrangement so that workers can release supports from outside the assessed collapse zone (Risk 2). Extended-handle interlocking clamps are a concept for evaluation. The Temporary Works Designer and C&S Engineer should verify capacity, locking and release sequence, cage stability and the safe operating position before adoption.	Temporary Works Designer C&S Engineer	Adapted from an incident. The design proposals have been generalised for this library. - WSHC (2014), Code of Practice on Safe Lifting Operations in the Workplaces.
			Engineering Control Design positive, unambiguous lifting points that prevent hooks engaging unintended rebars (Risk 1). An inverted-U lifting point or shaped guards may be assessed as concepts. The Temporary Works Designer and C&S Engineer should verify the complete load path, rigging compatibility and cage reinforcement. Visual or tactile cues supplement physical prevention; they do not demonstrate lifting capacity.	Temporary Works Designer C&S Engineer	
2	Retaining wall or basement wall located immediately	Adapted A&A scenario: a retaining structure is introduced close to an existing building without adequate allowance for	**Elimination / Substitution** - Set back or separate the retaining structure from the building where	Geotechnical Engineer	CROSS Safety Report 1420: Poor retaining

#	Component & Case Details	Design Risk	Proposed DfS Control Measure(s)	Relevant Stakeholder	References
	adjacent to a building superstructure  *Figure 1: indicative section through building* Case ID: SUB-002. Activity: A&A and maintenance. Design stage: Concept / detailed design.	movement, groundwater or drainage deterioration. Unintended lateral load transfer can destabilise the building or retaining structure, exposing construction and maintenance workers to collapse. This A&A application is adapted from CROSS Safety Report 1420.	practicable, so that wall movement does not impose load directly on the superstructure. **Engineering Controls** - Assess groundwater, discharge capacity and deterioration or blockage of drainage over the design life. Check the retaining wall for the resulting credible water-pressure conditions and provide maintainable drainage. - Determine wall movements and appropriate earth-pressure assumptions, including restricted movement, and provide adequate separation or design the interface for the transferred loads. - Detail the structure to avoid unintended load transfer to slabs, braces, frames, or other structural elements. - Where load transfer cannot be avoided, ensure the receiving structure is designed to safely support it. **Administrative Controls** - Record dependencies on drainage performance, dewatering, or maintenance of discharge paths as residual design risks. - Clearly communicate the retaining wall-building interface assumptions in design documents and the DfS register.	C&S Engineer Architect Building Owner Facilities Manager	wall design threatens stability of a multi-storey steel frame building.

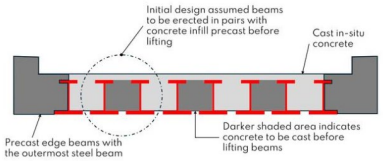
#	Component & Case Details	Design Risk	Proposed DfS Control Measure(s)	Relevant Stakeholder	References
3	Deep excavation / retaining structure exposed to heavy rainfall, inundation, or groundwater pressure  *Figure 1: Indicative section through excavation and retaining wall*  Case ID: SUB-003. Activity: Excavation. Design stage: Detailed design / pre-construction.	An excavation support design that does not address inundation and changing temporary conditions can lose stability during heavy rainfall, exposing workers and users of adjacent infrastructure to collapse. Note: CROSS Report 1385 describes such a collapse; the complete combination of contributing factors was not established.	**Elimination / Substitution** - Assess whether the excavation depth, layout or construction sequence can be changed to reduce exposure to inundation and the consequences of support failure. **Engineering Controls** - Check stability at each excavation stage under credible inundation, groundwater and drainage-failure conditions, including effects on soil resistance and adjacent assets. - Design drainage, dewatering and overflow routes for the assessed conditions. Identify dependencies on pumping and the response required if drainage or power is lost. **Administrative Controls** - Agree monitoring, warning and evacuation triggers with the contractor and adjacent infrastructure owners; state who reviews conditions and authorises work to resume. - Record key hydrological assumptions and residual risks in the DfS register.	Geotechnical Engineer C&S Engineer Temporary Works Designer Main Contractor Adjacent Infrastructure Owners	CROSS Safety Report 1385: Collapse of a five storey high retaining wall.

2 Bridges

No.	Component & Case Details	Design Risk	Proposed DfS Control Measure(s)	Relevant Stakeholder	References
1	 Link Bridge / Sky Bridge Column  Link Bridge Between Residential Blocks Case ID: BR-001. Activity: Bridge erection. Design stage: Concept / detailed design.	**Standalone Bridge Column** - Column height and geometry require elevated access and tall formwork, exposing workers to falls, falling objects and temporary-works collapse. - Foundation depth and arrangement introduce excavation collapse, water ingress and piling-related struck-by risks; assess confined-space hazards where applicable. - Restricted space, inadequate scaffold tie provisions or proximity to traffic increase instability and vehicle-impact risks. - Component weight and connection details create lifting, crushing and work-at-height risks during installation.	**Elimination** - Eliminate the separate column and its associated foundation and column-construction exposure where structurally feasible.  - Assess supporting a prefabricated bridge from the main building frames. The C&S Engineer should verify support capacity, load transfer, differential movement, bearing arrangements and temporary stability during erection. - Removing the column does not remove bridge-erection risks; a checked installation sequence and temporary support design remain necessary.	Architect C&S Engineer Structural Contractor	- BCA Approved Document – Acceptable Solutions (Version 7.08, 2025) - WSH (Work at Heights) Regulations 2013 - WSH (Scaffolds) Regulations 2011 - SS 659:2020 Code of Practice for Scaffolds; SS 580:2020+A1:2025 Code of Practice for Formwork - SS 607:2015 — System design. - SS 570-
			Substitution	C&S Engineer	

No.	Component & Case Details	Design Risk	Proposed DfS Control Measure(s)	Relevant Stakeholder	References
			- Where a column remains necessary, assess prefabrication to reduce work at height, with checked lifting points, connections and temporary stability. For bridge installation, assess crane lifting or strand jacking against the required lifting loads, support reactions, access and temporary works.	Contractor	1:2022 — Single-point anchors. - SS 570-2:2022 — Horizontal lifelines. - WSHC (2013), sections 7–9 (anchorage, restraint and fall arrest). - WSHC (2014), Code of Practice on Safe Lifting Operations in the Workplaces
			Engineering Controls - Design for temporary bracing on scaffolds to resist lateral wind forces. - Design traffic-impact protection for exposed falsework and coordinate its position and capacity with temporary works and traffic arrangements.	Architect Main Contractor C&S Engineer Site Supervision Team Road Planner	
			PPE - Personal protection for remaining exposure: design compatible anchorage and lifelines where collective protection is not practicable; specify safe access, fall clearance where relevant and rescue arrangements.		

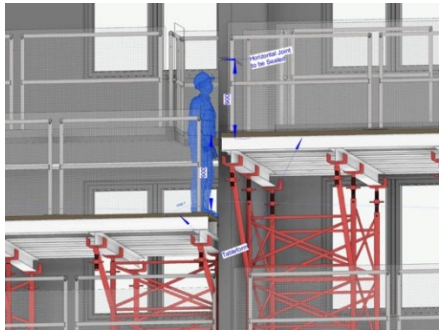
No.	Component & Case Details	Design Risk	Proposed DfS Control Measure(s)	Relevant Stakeholder	References
2	High-rise Link Bridges  Case ID: BR-002. Activity: Façade installation and maintenance. Design stage: Concept / detailed design.	**Bridge Façade Installation and Maintenance:** Installation of façade at height on the external surface of link bridges: Poses risks of falling from height and being struck by falling objects during façade installation; Inadequate access for future inspection and maintenance of the façade exterior: Requires temporary solutions such as scaffolding erection or rope access, thereby increasing the risk of falls from height.	**Elimination:** - Design connection points to be fixed from the interior to eliminate the need for external working at height during installation.	Architect Façade Consultant Structural Engineer	- BCA DfM Guide: Residential, Version 2.0 (2022) - BCA Façade Access Design Guide (2019) - WSH (Work at Heights) Regulations 2013 - SS 607:2015 — System design. - SS 570-1:2022 — Single-point anchors. - SS 570-2:2022 — Horizontal lifelines. - WSHC (2013), sections 7–9 (anchorage,
			Substitution - If installation connections cannot be within protected internal working areas, minimise the number of external connections and assess the remaining exposure. - Assess lighter, durable modular panels where they reduce handling and replacement exposure. Specify verified performance for the project's wind, impact, fire, weathering and fixing requirements; a material description alone does not establish suitability.	Architect Façade Consultant Supplier	
			Engineering Controls - Separate the bridge erection plan from the façade access design. Any proposed launching or lifting method requires checked support reactions, restraints and temporary stability. - Design façade installation platforms, lifting/handling points and connection access for the selected module sizes and installation sequence. - Where inward-rotating panels are proposed, provide safe internal access	Structural Engineer Façade Consultant Main Contractor Maintenance Team or Facilities Manager	

No.	Component & Case Details	Design Risk	Proposed DfS Control Measure(s)	Relevant Stakeholder	References
			for maintenance. Verify hinges, restraints, locks, rotation clearance and safe panel replacement. - Validate critical installation and access details through design checks and suitable mock-ups. Monitoring supplements, but does not replace, physical protection and structural verification. - Off-site prefabrication of façade modules to minimise on-site high-level work.		restraint and fall arrest).
			PPE - PPE for remaining exposure: provide compatible anchorage and lifelines accessible from protected positions, with a verified restraint or fall-arrest strategy.		
3	Bridge deck composed of steel filler beams connected in pairs with precast concrete  *Figure 1: cross section through the bridge deck as designed showing pairs of beams with concrete precast before lifting. Note that this is not the final design which included bracing.* Case ID: BR-003. Activity: Bridge erection and concreting.	The intended steel-concrete pairs are too large or costly to lift, leading the contractor to change the erection sequence and lift individual filler beams instead. This can create a temporary instability risk, as single beams or insufficiently restrained beam pairs may undergo lateral torsional buckling during lifting or under wet concrete loading.	**Elimination/Substitution:** - Where practicable, redesign the deck or erection unit so that each lifted and erected unit is inherently stable within realistic lifting constraints. This may include self-stable modular steel assemblies, permanent diaphragms/cross-frames installed early, or alternative deck arrangements that provide restraint before concreting. **Engineering Control:** - Produce a checked erection sequence and restraint arrangement for lifting, placement and concreting, with positive	Structural Engineer Main Contractor Temporary Works Designer Temporary Works Coordinator or project-equivalent role	CROSS Safety Report 1479: Temporary stability risk due to construction changes on bridge deck.

No.	Component & Case Details	Design Risk	Proposed DfS Control Measure(s)	Relevant Stakeholder	References
	Design stage: Detailed design / pre-construction.		lateral and torsional restraint at every critical stage. **Administrative Control:** - Assign temporary and permanent works design interfaces and coordination responsibilities. If erection unit size or lifting sequence changes, the PE responsible for temporary works shall recheck the revised stages and update the drawings. The appointed independent checking PE shall check safety-critical revisions before the responsible PE issues the drawings for use. Communicate the revised sequence and restraints to the site team before execution.	Independent Checker	

3 Building Envelope

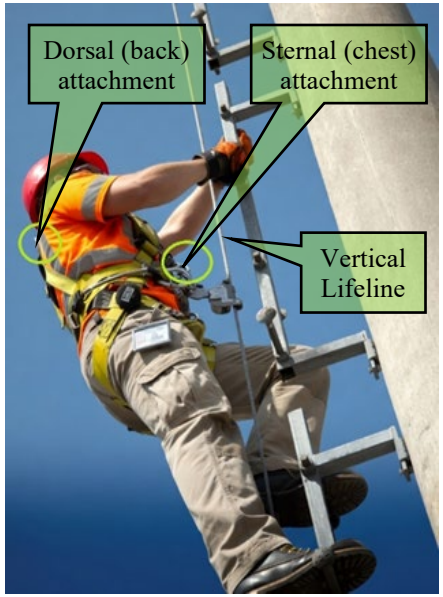
#	Component & Case Details	Design Risk	Proposed DfS Control Measure(s)	Relevant Stakeholder	References
1	External RC ledges surrounding a building  Case ID: BE-001. Activity: Inspection and maintenance. Design stage: Concept / detailed design.	The 1 m external RC ledge without edge protection, the absence of access for suitable work platform (e.g., Mobile Elevating Work Platform, MEWP), and absence of permanent fall protection anchorage points create a foreseeable fall-from-height risk during inspection, painting, and maintenance works.	**Elimination/Substitution** Confirm the ledge's function and remove it where it is unnecessary. If shading is required, assess alternatives such as louvres or blinds, including safe inspection, cleaning and replacement access and the hazards introduced by their fixings and operation.	Architect	Adapted from an incident. The design proposals have been generalised for this library. BCA Approved Document, Section H — Safety from Falling SS 616:2016 — Safe use of MEWPs SS 607:2015 — Fall-protection system design SS 570-1:2022; SS
			Engineering Control - Design permanent edge protection and protected access to the ledge; any foldable system should be safely deployed and secured before exposure. - Where MEWP access is selected, provide the complete access route and working space, with suitable geometry and verified supporting capacity.	Architect C&S Engineer	
			PPE - Where collective protection is not practicable, provide a designed personal protection system with a safe attachment position. - Verify the restraint or fall-arrest arrangement, supporting structure, compatibility, inspection access and rescue provisions.	Architect C&S Engineer Fall-protection Specialist Contractor	

#	Component & Case Details	Design Risk	Proposed DfS Control Measure(s)	Relevant Stakeholder	References
					570-2:2022 — Anchors and horizontal lifelines - WSH (Work at Heights) Regulations 2013, regulations 8–12 (barriers, restraint, arrest and inspection). - WSHC (2013), section 9.5 (rescue).
2	Sealing of external precast component joints at height 	**Risk 1 —** External joints beyond reach from a protected floor or platform require installers to work outside the protected area, exposing them to a fall during sealing. **Risk 2 —** Gaps, exposed table-form edges or incompatible temporary works arrangements create fall hazards during access and joint sealing.	**Elimination / Substitution** - C&S engineer and Precaster: assess joint detailing that permits sealing from a protected internal position, eliminating the need to leave that position (Risk 1). - If internal sealing is not feasible, select an alternative protected access method as described below. - Designer and Temporary Works Designer: coordinate the selected access method with table-form	C&S engineer Precaster Temporary Works Designer	Adapted from a practitioner's example. The design proposals have been generalised for this library.

#	Component & Case Details	Design Risk	Proposed DfS Control Measure(s)	Relevant Stakeholder	References
	Case ID: BE-002. Activity: Joint sealing. Design stage: Detailed design / pre-construction.		movement, dismantling and other construction stages (Risks 1 and 2). - Substitution: assess sealing from a mast-climbing or suspended platform at an appropriate construction stage, with checked supports, access and work sequencing (Risk 1).		SS 580:2020+ A1:2025 — Formwork design, use and dismantling SS EN 13374:2018 — Temporary edge protection SS 607:2015 — Fall-protection system design SS 570-1:2022; SS 570-2:2022 — Anchors and horizontal lifelines - SS 598:2014 — Suspended scaffolds
			Engineering Controls - Temporary Works Designer: detail edge protection on exposed table-form edges and its supporting connections (Risk 2). - Ensure the guardrail system does not compromise table-form structural stability or lifting operations. - Temporary Works Designer: provide checked bridging/infill platforms where needed and prevent access to unprotected gaps (Risk 2). - Temporary works layout, installation and dismantling sequence to be clearly detailed and approved.	Designer Precaster Temporary Works Designer	
			Personal protection for remaining exposure - C&S engineer and Temporary Works Designer: provide compatible anchorage integrated with the supporting structure where collective protection cannot address the remaining exposure.	C&S engineer Temporary Works Designer	

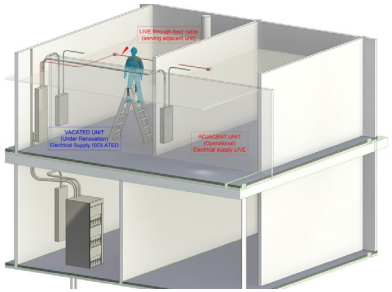
#	Component & Case Details	Design Risk	Proposed DfS Control Measure(s)	Relevant Stakeholder	References
			- Table forms not to be used as anchorage unless engineered and approved. - Prefer a verified travel-restraint arrangement that prevents reaching a fall position. If fall arrest is necessary, verify clearance, equipment compatibility and rescue arrangements. - Complement with project-specific Method Statement, Risk Assessment, SWP, FFH training and warning signage.		(for the suspended-platform option). - WSHC (2013), sections 6.6–6.7 (suspended and mast-climbing platforms), 9.5 (rescue). - WSH (Work at Heights) Regulations 2013, regulations 8–12.
3	Fully reversible cleaning windows in high-rise buildings	Safety-critical window hinges that are difficult to inspect or unsuitable for the complete window configuration can fail in service. Detachment exposes people below to falling objects and leaves an unprotected opening for occupants and maintenance workers. CROSS Report 1477 describes hinge failures; their underlying cause was not definitively established.	**Elimination / Substitution** - Avoid window systems that depend on concealed or difficult-to-inspect safety-critical components in high-risk high-rise applications. **Engineering Controls** - Verify the complete window system for its size, mass, operating cycles, wind exposure and environment; component certification alone may not cover the installed configuration.	Architect Façade Consultant Window Supplier/ Designer Building Owner Facilities Manager	CROSS Safety Report 1477: Risk of hinge failure in reversible windows installed in high-rise buildings.

#	Component & Case Details	Design Risk	Proposed DfS Control Measure(s)	Relevant Stakeholder	References
	 *Image 1: failed window hinge* Case ID: BE-003. Activity: Operation and maintenance. Design stage: Detailed design.		- Window supplier/designer to demonstrate that safety-critical hinges and restraints can be inspected and replaced while the opening window panel is securely supported against falling and the opening protected against falls. Provide maintenance-access details and panel-support and opening-protection drawings. - Provide protection against the exposed opening in the event of component failure. **Administrative Controls** - Window supplier/designer to provide an inspection/replacement procedure. Include inspection requirements, access method and replacement criteria in the maintenance strategy. - Highlight any certification limitations and operational restrictions relevant to the selected system.		**Source limitation:** The cause of hinge failure remains unresolved. The maintainability control is a proposed adaptation, not a confirmed finding about the failure cause. - BCA Approved Document (2025), Sections H (fall protection) and M (window safety). - WSH (Work at Heights) Regulations 2013,

#	Component & Case Details	Design Risk	Proposed DfS Control Measure(s)	Relevant Stakeholder	References
					regulations 8–9 (openings and barriers).
4	Safe means of access for vertical structures  Case ID: BE-004. Activity: Maintenance access. Design stage: Concept / detailed design.	A vertical access arrangement with inadequate footholds, handholds, clearances or protected transitions can cause maintenance workers to lose balance and fall while climbing or entering the work area. Design checks should include: - Rung spacing and geometry appropriate to the access task - Secure handholds and footholds, clearances and safe transitions at landings - Usable width and compatibility with tools, equipment and the selected protection system	**Elimination and substitution of ladder access** - Prefer suitable permanent stairs or protected access platforms where practicable. - Where these are not practicable, assess a MEWP or another purpose-designed access system against access geometry, supporting capacity and the maintenance task. **Personal Fall Arrest Systems (PPE)** - Select guided fall arrester or SRL, connectors and harness attachment in accordance with the complete system's design and manufacturer instructions. Do not select a dorsal attachment solely because it is common. Verify transitions, clearance, supporting structure and rescue arrangements.	Designer Owner Facilities Manager	- HSE RR258 - OSHA 29 CFR 1910.28(b)(9) - HSE RR657 - SS 570-1:2022 - WSHC Anchorage Guidelines (2012), sections 2.9, 3.5–3.7 and 3.11 - ISO 14122-4:2016 - WSH (Work at Heights) Regulations 2013, regulations 11–14 and

#	Component & Case Details	Design Risk	Proposed DfS Control Measure(s)	Relevant Stakeholder	References
					18. - SS 607:2015 — System design. - SS 528-3:2006 (2026) — SRLs. - SS 528-4:2006 (2026) — Vertical lifelines. - SS 616:2016 — MEWPs.

4 Electrical System

#	Component & Case Details	Design Risk	Proposed DfS Control Measure(s)	Relevant Stakeholder	References
1	Fatal electrocution from hidden live through-feed cable during renovation works  Case ID: EL-001. Activity: Renovation. Design stage: Detailed design.	Cross-unit live cables routed through a separately tenanted space, without adequate segregation, identification or accessible isolation, may remain energised during renovation. Workers disturbing these cables can suffer electric shock or electrocution. Missing or inaccurate single-line diagrams and routing records can further obscure this exposure.	**Elimination / Substitution** - Design electrical distribution so each unit/zone can be fully isolated when vacated. - Prefer routing sub-main cables outside other tenants' private spaces, to avoid exposure during unrelated renovation work. - Use dedicated risers or landlord-controlled service routes. Where cross-unit routing is unavoidable, document the justification and provide accessible isolation, physical protection and clear ownership identification. - Adopt modular, zone-based layouts for independent isolation. - Coordinate the distribution layout with renovation and maintenance access so the relevant circuits can be identified and isolated independently. - Electrical Engineer responsible for the design to verify: have all supply paths into the work zone (including landlord, other-tenant and alternative supplies, where present) been identified, and is the proposed isolation boundary clearly shown on the coordinated drawings?	Licensed Electrical Worker (LEW) Electrical Engineer Building Owner / Landlord	Adapted from an incident. The design proposals have been generalised for this library. - SS 638:2018+C1:2020+A1:2022 — Code of practice for electrical installations (design and verification) .

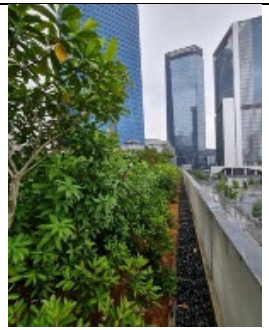
#	Component & Case Details	Design Risk	Proposed DfS Control Measure(s)	Relevant Stakeholder	References
			Engineering Controls - Provide accessible, lockable isolation points and suitable provisions for safe testing and verification of isolation. - Physically segregate tenant services using dedicated, clearly labelled conduits or colour-coded trays. - Provide physical separation and protection at access points where workers may encounter cables serving other units. - Provide rigid mechanical protection where cables run alongside other services. - Include routes and access space for isolation and testing in the electrical design. - Verify that the physical protection remains effective during foreseeable renovation and maintenance work.	Licensed Electrical Worker (LEW) Electrical Engineer Engineer	
			Administrative Controls - Provide and maintain single line diagrams (SLDs), routing drawings and, where used, BIM information identifying service ownership and isolation zones. - Provide durable labels, compatible colour identification and warnings at access points. Communicate the isolation and verification procedure; identification alone does not establish a de-energised condition.	Licensed Electrical Worker (LEW) Electrical Engineer Building Owner Facilities Manager	

#	Component & Case Details	Design Risk	Proposed DfS Control Measure(s)	Relevant Stakeholder	References
			- Maintain and update electrical documentation as safety-critical information throughout the building lifecycle.		

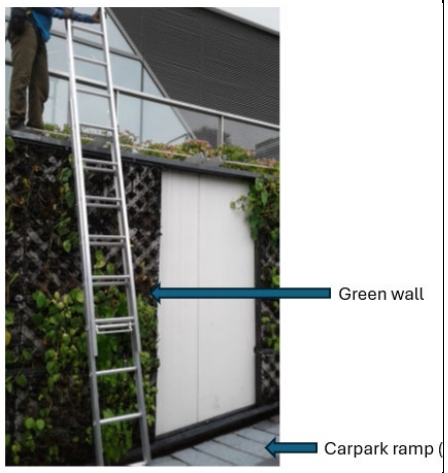
5 Landscaping

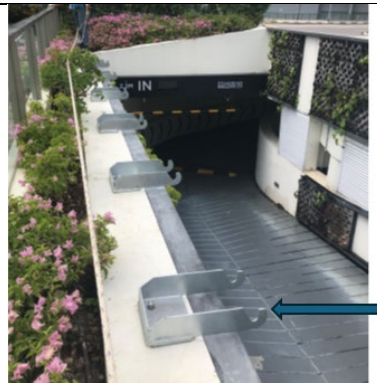
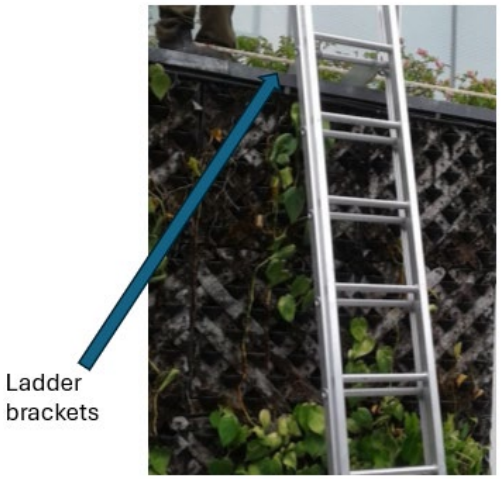
#	Component & Case Details	Design Risk	Proposed DfS Control Measure(s)	Relevant Stakeholder	References
1	Steep vegetated and mossy concrete slope  Case ID: LAN-001. Activity: Landscape maintenance. Design stage: Concept / detailed design.	The steep vegetated and mossy concrete slope increases the risk of landscaping workers slipping or falling off the slope when trimming grass on the slope during maintenance.	**Elimination of work on the slope** - Remove the need for workers to access the slope for planting maintenance where practicable. Vertical greening is an alternative only if all inspection, pruning, replacement and irrigation-system work can be carried out from protected level access.	Architect Landscape Architect	Adapted from a practitioner's example. The design proposals have been generalised for this library. - BCA Approved Document (2025), Section H (permanent barriers). - WSH (Work at Heights) Regulations 2013, regulations 8–12. - SS 607:2015 — System design. - SS 570-1:2022 — Single-point anchors.
			Substitution - Use low-maintenance or self-sustaining plant species to reduce frequency of work.	Landscape Architect	
			Engineering Controls - Provide edge protection for the relevant access and working positions. A barrier at the top does not protect workers already on the slope below it. - Add catwalks or platforms for safe access. - Where personal protection remains necessary, design protected access to compatible work-positioning/restraint or fall-arrest equipment and specify the supporting structure, clearance and rescue provisions.	C&S Engineer Architect	

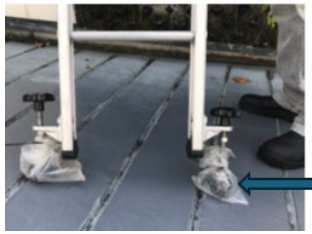
					- WSHC (2013), sections 5–10 (access, barriers, personal protection and work positioning).
2	***4 Similar Scenarios (A-D):*** **Landscaping Near Building Edges or Concealed Drop-offs**  *Area below is made of timber planks (not suitable for MEWP)* *Scenario A:* Planter box along a building edge (narrow ledge access)	**Risk 1: Fall from Height Due to Edge Proximity** *(Scenarios A, B, C, D)* Landscaping maintenance requires workers to approach building edges, elevated platforms or drop-offs where barriers are absent or inadequate, exposing them to a fall to a lower level. **Risk 2: Concealed/Hidden Hazard Detection Failure** *(Scenarios B, C, D)* Vegetation conceals open drainage trenches, gaps or changes in level, allowing workers to step into an opening or trip and fall. Poorly visible glass barriers may cause workers to collide with them and lose balance. **Risk 3: Unstable Access and Surface Conditions** *(Scenarios A, C, D)* Narrow maintenance ledges provide insufficient space for secure footing. Root-damaged surfaces and water spillage create trip and slip hazards, potentially causing workers to fall, including over an adjacent unprotected edge.	**Elimination** - Remove planting from narrow, elevated ledges that do not provide safe access for maintenance *(Risk 1, Risk 3)*. - Set planters back sufficiently to create a protected maintenance corridor; determine the width from the task, equipment and edge-protection arrangement rather than a universal 1 m setback (Risk 1). - Avoid planting tall shrubs at building edges; reserve areas for clear walkways *(Risk 2)*. **Substitution** - Select low-maintenance species to reduce watering and pruning. Where artificial planting is proposed, the designer shall compare access needs for cleaning, fixing inspection and replacement, fire/material suitability, and detachment or falling-object risks before adopting it as a safer substitute *(Risk 1)*. - Select planting heights and species that maintain visibility of paths, edges and covers. Determine clearances based on mature vegetation size *(Risk 2)*.	Architect Landscape Architect Landscape Architect	- BCA DfM Guide: Residential, Version 2.0 (2022), A3.15 and K1.1–K1.5 - PUB Code of Practice on Surface Water Drainage (7th ed., Addendum No. 3, 2025) - WSH (Work at Heights) Regulations 2013 - SS 570-2:2022 Flexible horizontal lifeline systems

	 *Scenario B:* Dense vegetation edge with drainage trench (concealed planter/trench edge)  *Scenario C:* Trees/shrubs near building edge (Vegetation Masking)		- Specify paving with slip resistance suitable for expected wet conditions, maintenance activities and drainage arrangements *(Risk 3)*.		Note: These supporting references do not establish **universal planter or lifeline offsets.** - BCA Approved Document (2025), Section H (permanent barriers). - SS 607:2015 — System design. - SS 570-1:2022 — Single-point anchors. - SS 616:2016 — Safe use of MEWPs. - WSHC (2013), sections 6.1–6.2, 8–9 (edges, openings, restraint and fall arrest).
			Engineering Controls: - **Edge Protection & Access:** • Provide dedicated maintenance walkways and platforms with stable footing *(Risks 1 and 3)*. • Design continuous guardrails/parapets between maintenance areas and drop-offs, with height, openings and strength meeting applicable project requirements *(Risk 1)*. • Provide suitable MEWP access routes and working space, with verified clearances and supporting capacity *(Risk 1)*. • Provide hinged, lockable drainage covers. The designer shall identify pedestrian and maintenance-equipment loads that can reach each cover and verify the cover, frame and surrounding support for those loads. Detail inspection and cleaning arrangements that prevent exposure to an unprotected opening *(Risk 2)*.	Architect C&S Engineer Fall protection specialist	

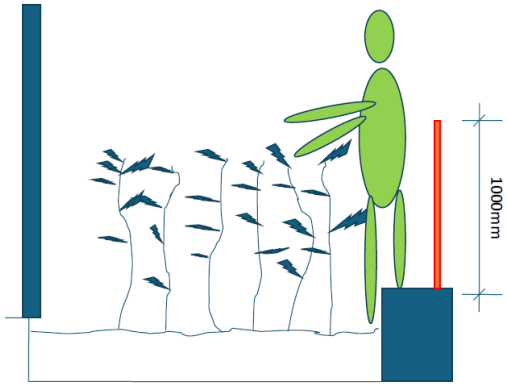
	 *Scenario D:* Multi-level planter near railing (invisible glass panels, hidden edges) Case ID: LAN-002. Activity: Landscape maintenance. Design stage: Concept / detailed design.		**- Surface Stability:** • Landscape designer and C&S Engineer to detail root-management measures that prevent damage to maintenance walkways, while maintaining plant stability, drainage, waterproofing and replacement access *(Risk 3)*. • Provide internal drainage with overflow control and weep holes *(Risk 3)*. **Administrative Controls:** **- Hazard Visibility & Detection:** • High-contrast, anti-slip tactile strips and LED strip lighting for edge definition *(Risk 2)*. • Add decals, strip markers or frosted bands at eye level on glass panels *(Risk 2)*. **PPE - Fall Protection Systems:** • C&S Engineer and fall-protection specialist to select anchorage locations only after verifying the load path into the supporting structure, system compatibility, inspection access and installation constraints. Do not assume façade or planter elements are suitable supports *(Risk 1)*. • Design lifeline location and connector length together so travel restraint prevents reaching any fall position; an offset alone does not demonstrate protection *(Risk 1)*.		

			• Provide safe access to connection points and verify the complete restraint system. Where fall arrest is necessary, also verify fall clearance, equipment compatibility and rescue arrangements *(Risk 1)*.		
3	Green wall along a carpark ramp  Case ID: LAN-003. Activity: Landscape maintenance. Design stage: Concept / detailed design.	The green wall along the carpark ramp increases the risk of landscaping workers falling off work platforms or ladders when maintaining the green wall.	**Elimination** - Consider removing or relocating the green wall so routine maintenance can take place from protected level access rather than on the vehicle ramp.	Architect Landscape Architect	Adapted from a practitioner's example. The design proposals have been generalised for this library. - WSH (Work at Heights) Regulations 2013, regulations 4, 14 and 18 (avoidance, access and ladders). - WSHC (2013), sections 5 and 11 (access and ladder
			Substitution - Substitute the full height green wall with lower green features that do not require work at heights.	Architect Landscape Architect	
			Engineering Control - If ladder access remains appropriate, design ladder brackets at suitable intervals determined by the landscaping work requirements. Verify the bracket connections, ladder compatibility and safe working position.	C&S Engineer Contractor	

			  - Provide a stable, level working position and protection from ramp traffic. Adjustable feet alone do not demonstrate safe use on a slope; select equipment within its manufacturer's operating limits.		selection/use).

					
4	Vertical Green Wall in a Hotel  Case ID: LAN-004. Activity: Landscape maintenance.	Maintenance workers servicing the green wall may be exposed to slips, falls, or overreaching because planting pockets are located near the water feature without safe and stable access. The wet or uneven surface may require workers to use ladders or reach from unstable positions, increasing the likelihood of a fall from height.	**Elimination** - Automatic irrigation can eliminate routine manual watering at this location. Retain safe access for pruning, plant replacement, inspection and irrigation-system repair.	Architect Landscape Architect M&E Engineer	- NParks (2023) Greenery provision guidelines - BCA. (2019). Façade Access Design Guide. - MOM. (2013). WSH (Work at Heights) Regulations 2013. - MOM. (2015). WSH (Design for
			Substitution - **Modular planting trays**: Use removable planting modules that can be serviced from a safe walkway or platform, avoiding extended reach over the water feature.	Landscape Architect Contractor	
			Engineering Controls - **Raised, level maintenance walkway**: Provide a continuous, raised platform or catwalk in front of the wall, kept clear of pooling water (with anti-slip surfacing), so staff do not need to stand on wet ground near the water feature.	Architect C&S Engineer M&E Engineer	

	Design stage: Concept / detailed design.		- Provide edge protection appropriate to the actual fall hazard, with verified strength, openings and height. Provide stable access and working space clear of the water feature; where personal protection remains necessary, provide safely accessible compatible anchorage and a verified protection strategy. **- Edge lighting and visual cues**: Provide low-level lighting or high-contrast edge marking along the walkway and platform to highlight safe zones, even in low light.		Safety) Regulations 2015.- SS 570-2:2022 Flexible horizontal lifeline systems - *SS 616:2016 Safe use of MEWPs* - BCA Approved Document (2025), Section H (permanent barriers). - SS 607:2015 — System design. - SS 570-1:2022 — Single-point anchors. - WSHC (2013), sections 5–6 and 8–9 (protected access and personal protection).

5	 *Scenario A*: Lifeline installed at the edge of the planter box 	**Risk 1:** An attachment point approached via an unprotected planter edge exposes maintenance workers to a fall before they can connect to the lifeline (Scenario A). **Risk 2:** Vegetation can conceal anchors and create trip hazards; moisture exposure can deteriorate fittings, increasing the risk of failure when the protection system is used (Scenario B).	**Engineering Control** - Provide permanent edge protection and a protected access route to the attachment and working positions, reducing reliance on personal protection (Risk 1). 	Architect Landscape Architect	Adapted from a practitioner's example. The design proposals have been generalised for this library. BCA Approved Document (2025), Section H — Safety from Falling (permanent barriers) - WSH (Work at Heights)

	Scenario B: Planter-Area Anchor System with Potential Safety Defects Case ID: LAN-005. Activity: Landscape maintenance. Design stage: Detailed design.		**PPE** - Relocate anchor points outside planting zones onto hard surfaces or dedicated edge walkways ensuring clear visibility and access *(Risk 2).* - Select wire rope, fittings and anchor devices for the actual environmental exposure and complete-system requirements. Grade 316 stainless steel may be considered, but the material grade alone does not establish fitness for use. - Verify corrosion resistance, material compatibility and safe inspection/replacement access for the proposed assembly (Risk 2). - Locate the lifeline away from open edges (e.g., 300mm) and verify the complete travel-restraint arrangement. The selected geometry and connector length must prevent reaching any fall position and permit safe attachment (Risk 1). 	Landscape Architect C&S Engineer Contractor Maintenance Team or Facilities Manager	Regulations 2013, regulations 8–12. - SS 607:2015 — System design. - SS 570-1:2022 — Single-point anchors. - SS 570-2:2022 — Horizontal lifelines. - WSHC (2012), sections 2.9, 3.8–3.10 and 3.14–3.15 (inspection, geometry and deterioration).

			- Specify anchor assemblies with verified suitability for the selected system and applicable standards. Locate them on accessible supports clear of soil and vegetation; determine maintenance clearances from inspection and replacement needs, not a universal setback (Risk 2). - Assess drainage and moisture protection at anchor supports. Any gravel layer or protective sleeve is a proposed detail requiring validation for corrosion, trapped moisture, load transfer and inspection. - Where suitable, use manufacturer-supported condition indicators to assist inspection; these do not replace the specified inspection and replacement regime (Risk 2).		

6 Case Study

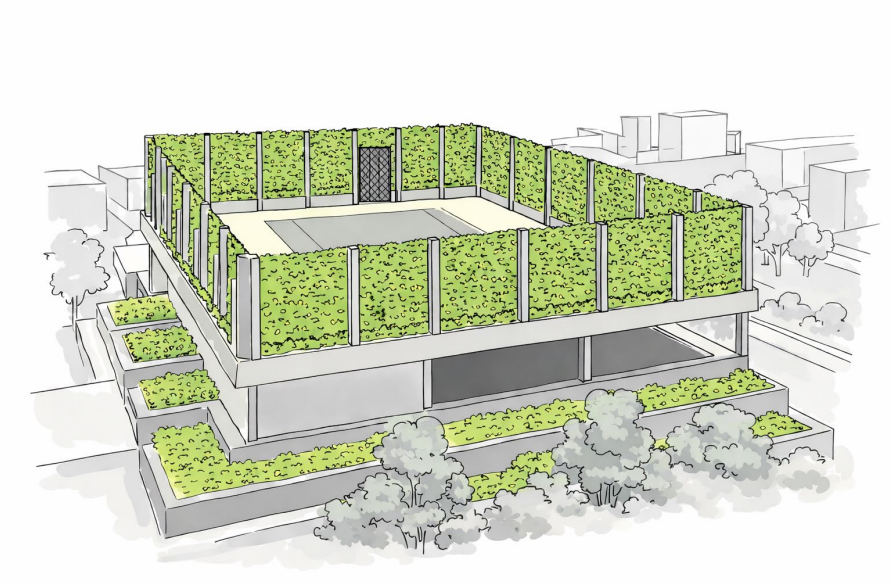
6.1 Landscaping Case Study – The Green Cascade Pickleball Court

Case ID: CS-LAN-001.

Lifecycle: maintenance and replacement.

Decisions: concept and detailed design.

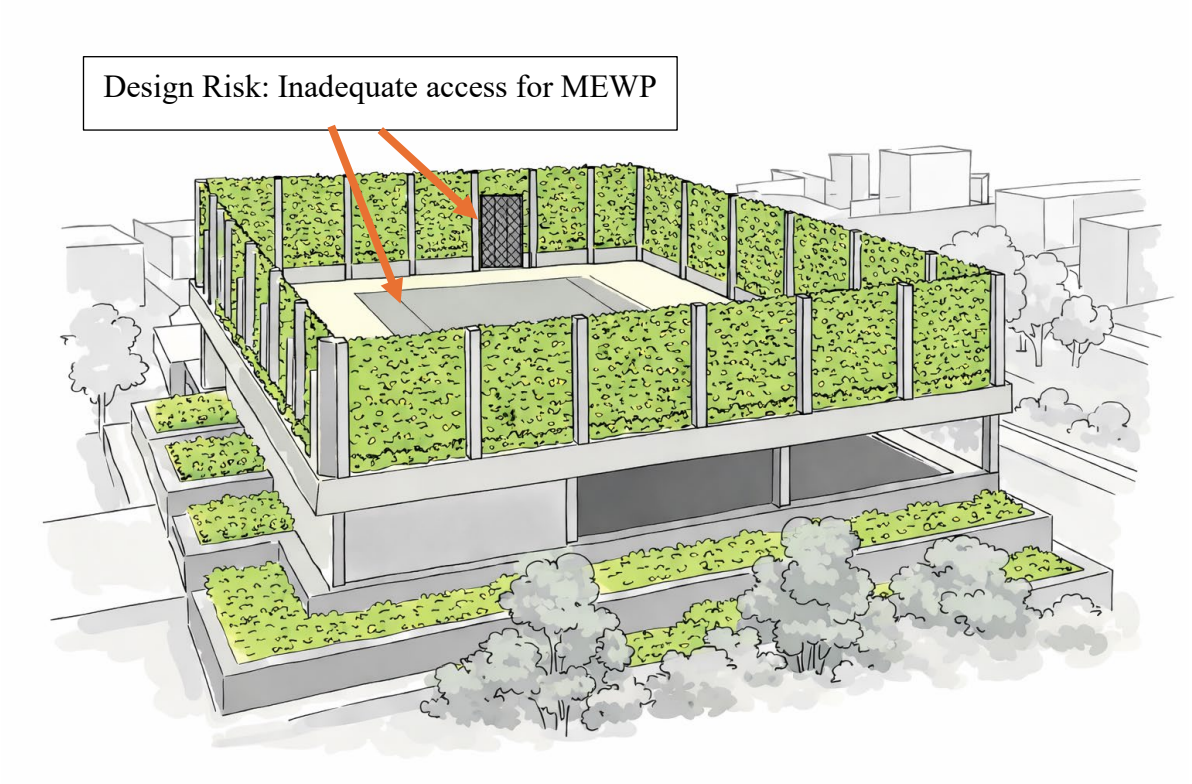
This anonymised practitioner's example concerns an elevated pickleball court with a vertical green wall and terraced planters. The proposed design changes below adapt the example for DfS discussion; they do not represent verified as-built solutions.



6.1.1 Design Concept

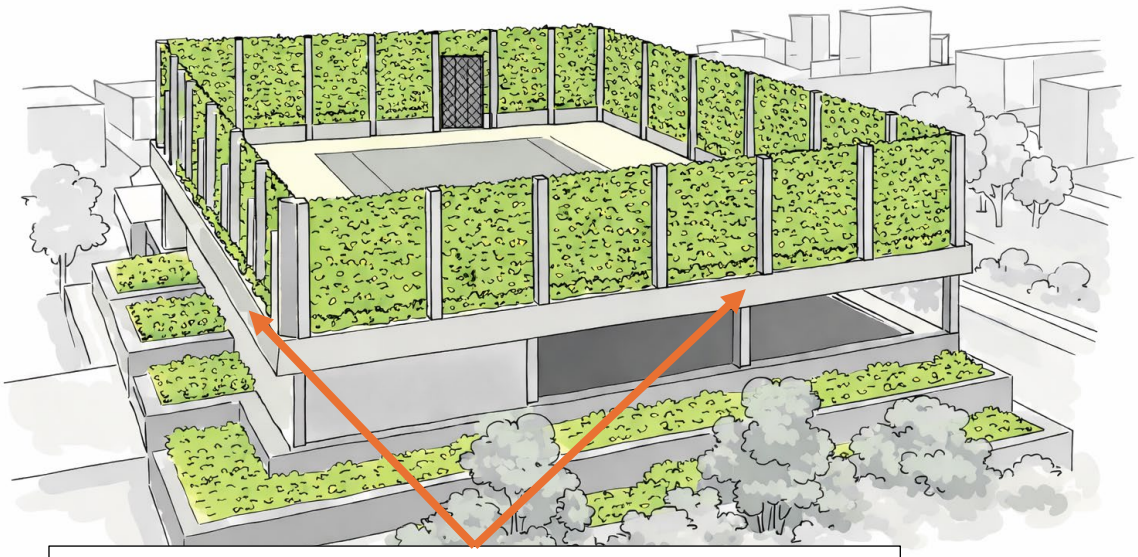
The design concept for this elevated pickleball court integrates greenery and sustainability through a continuous vertical green wall and a series of terraced green features. The lush green façade, supported by planter boxes, encloses the court to provide privacy, reduce noise, and create a strong natural aesthetic. In addition, the stepped, terraced planting at the lower levels softens the building mass, enhances visual continuity with the surrounding landscape, and improves microclimatic performance. These layered green elements blend the court seamlessly into its landscaped environment of stylised trees and shrubs.

6.1.2 Design Risks and Possible Design Changes



The following design proposals address façade and landscape maintenance access, with reference to BCA's Design for Maintainability Guide: Residential, Version 2.0 (2022). The proposals require project-specific design verification.

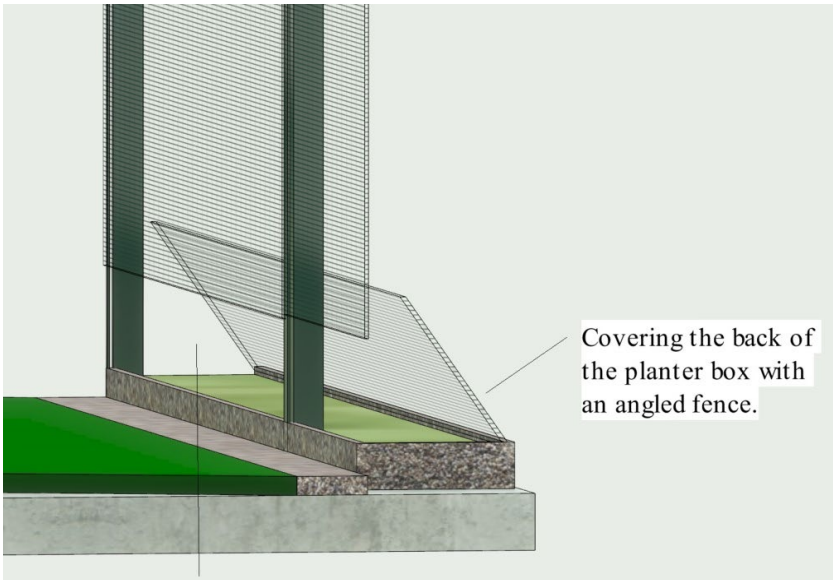
1. Use of MEWP for Façade Maintenance (BCA DfM Guidelines A1.6 and K1.3)
    a. Design Risk: The lack of an unobstructed, level access route and sufficient working space for MEWPs may lead to equipment instability and falls. Inadequate structural capacity beneath the court area may cause MEWP instability, increasing tip-over risks.
    b. Possible design changes (Architect, Landscape Architect and C&S Engineer, with the access-equipment specialist): provide a clear, level route and working positions for the selected MEWP. Check equipment dimensions, turning space, working envelope and imposed loads on the entire supporting structure.
        i. If the MEWP enters via the court, show its complete delivery route to court level, through the entrance and to every working position. Verify transport/lifting arrangements, clearances and supporting capacity. Compare this with protected court-side access that could remove the MEWP requirement for some maintenance tasks; neither option is established as safe solely by the illustration.



Design Risk: Planter boxes hard-to-reach, lack edge protection, anchorage points, designated access points, and stable and wide access route

Supporting reference for MEWP access: SS 616:2016, Code of practice for safe use of mobile elevating work platforms.

2. Maintenance safety and planter access, BCA DfM Guide: A1.8 (maintenance safety); A3.15, K1.1 and K1.7 (planter access and working space); K1.4 (green-wall rear access); K1.5 (designated inspection/access points).
    a. Design Risk: The planter boxes are located outside the court and are difficult to reach. The maintenance area lacks edge protection, anchorage points, designated access points and a stable, sufficiently wide access route. These conditions can lead workers to use unsafe positions or equipment, increasing fall hazards.
    b. Possible design changes (action by Architect and Landscape Architect):
        i. Eliminate the need to work from the outside ledge where feasible by providing court-side access to the planters. The Architect and Landscape Architect, with the C&S Engineer, should design protected maintenance openings, working space and edge protection, including any angled fence shown. Secure openings during normal court use and maintain protection while they are open for maintenance.



ii. Engineering controls: provide permanent collective edge protection and stable access; separate court users from maintenance and falling-object zones.
iii. PPE: where needed, provide safely accessible compatible anchorage and distinguish travel restraint from fall arrest, with the corresponding clearance and rescue provisions.

Supporting references for barriers and personal protection: BCA Approved Document (2025), Section H; WSH (Work at Heights) Regulations 2013, regulations 8–12; SS 607:2015 (system design); SS 570-1:2022 (single-point anchors); WSHC (2013), Working Safely at Heights, sections 8–9 (restraint, fall arrest and rescue).

6.1.3 Other Considerations

Plan access for watering and irrigation repair, pruning, plant and substrate replacement, drainage clearance, and inspection/replacement of the green-wall supports and court-side barriers. Agree task frequencies, equipment and handling needs with the Facilities Manager.

Protected court-side access can remove external ledge work for reachable planters; verify reach, working space, secured openings and falling-object protection. MEWP access can serve otherwise unreachable areas but requires a checked delivery route, support capacity, working envelope and separation from users. Assess a combined approach where neither option alone covers all tasks.

Document tasks that still require personal protection, handling of replacement modules, drainage and irrigation maintenance, access restrictions, inspection criteria and rescue arrangements. The Architect and Landscape Architect should coordinate the access design; the C&S Engineer should verify supports and loads; the Facilities Manager should confirm the maintenance strategy.

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