

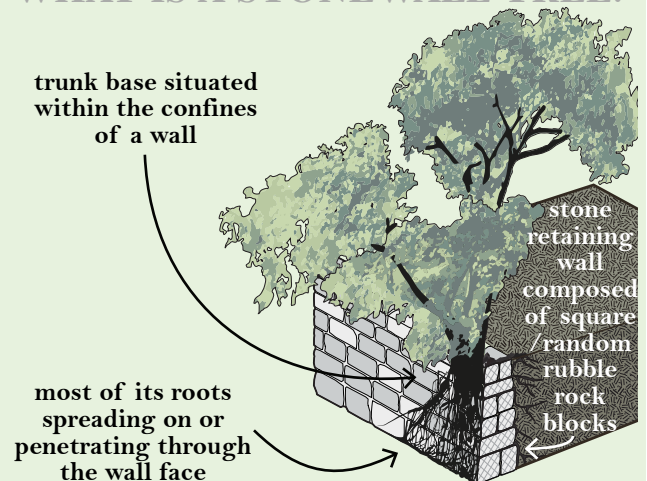
[Contents](#) [Previous](#) [Next](#)

## STONEWALL TREE MANAGEMENT A MULTI-DISCIPLINARY APPROACH

### PROLOGUE

Weaving its way through the dense concrete jungle, a bird would not spare a thought for the diversity of lives around it. It would not know how the seed in its beak would germinate to become a tree, just like how the general public under the canopy would not notice the meticulous efforts made to manage the trees above them.

### WHAT IS A STONEWALL TREE?

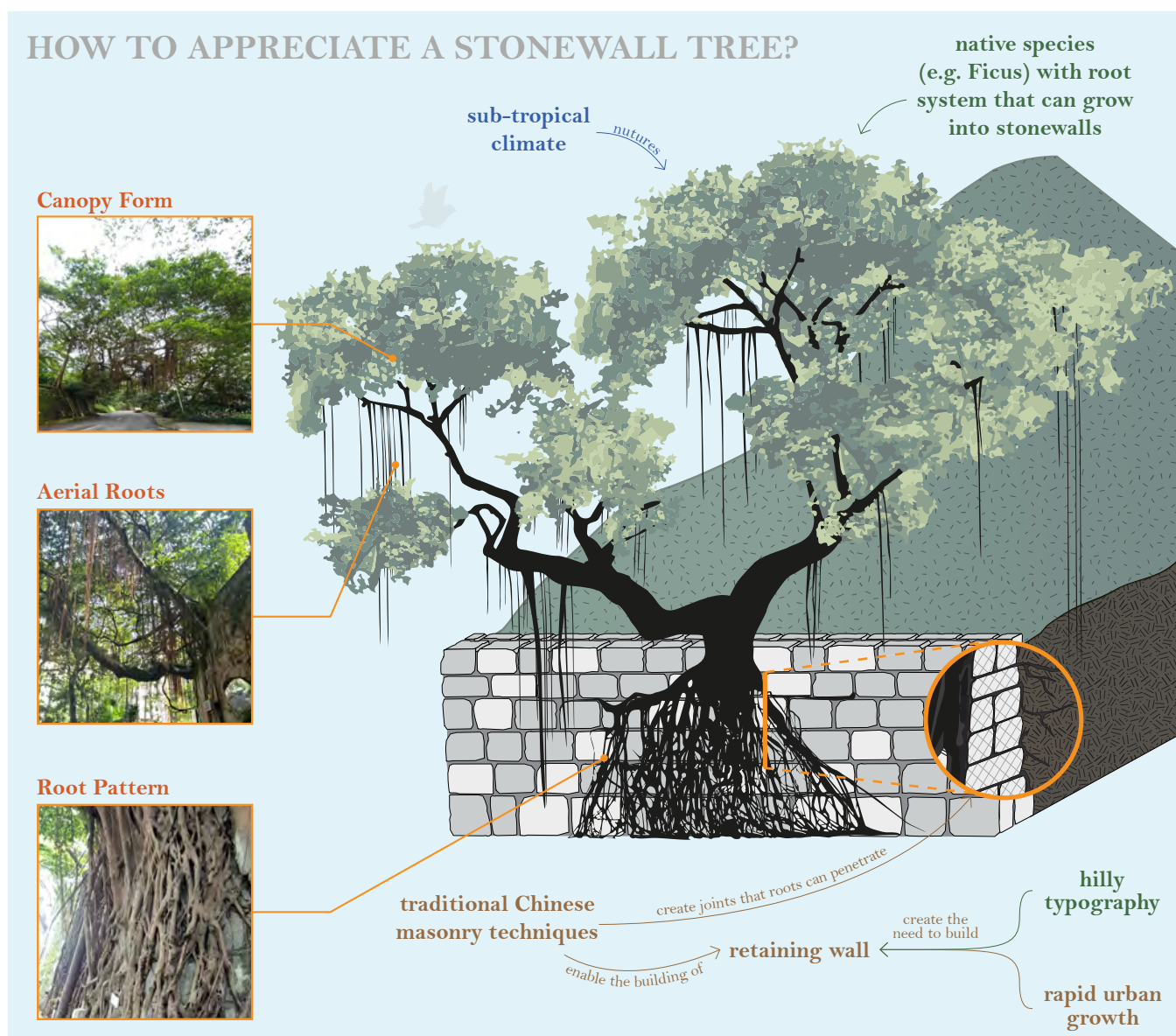


Trees on walls with stone facings do not count as stonewall trees.

## OUR STONEWALL TREES (SWTs)

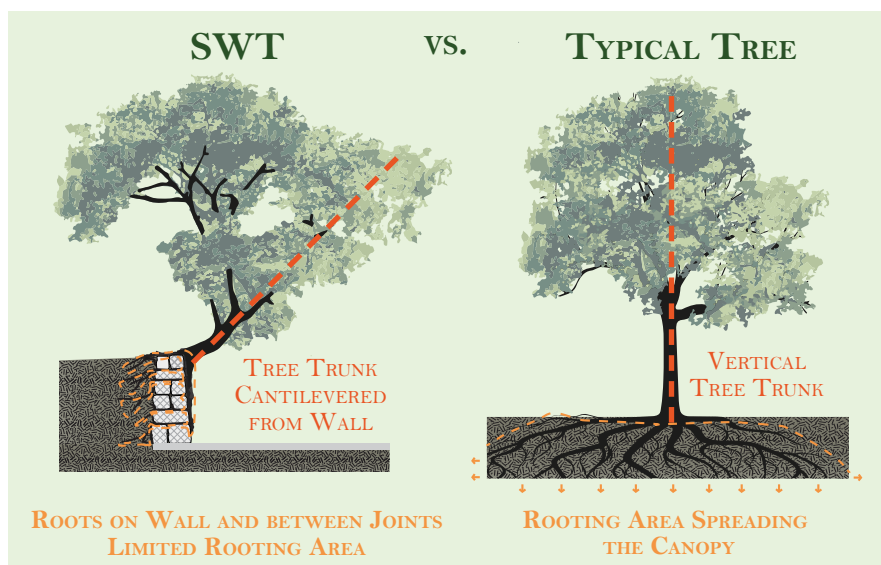
Stonewall trees (“SWTs”) are our unique landscape, ecological and amenity assets. Growing on stonewalls, the SWTs contribute to the unique cityscape of Hong Kong. They are the result of favourable climatic conditions (i.e. a sub-tropical climate that nurtures species such as Ficus), geographical conditions and human activities (i.e. hilly terrain leading to the building of retaining walls and terraces). Ever since modern concrete retaining walls have become the standard, masonry walls made by traditional craftsmanship are no longer built. As these concrete retaining walls have no cracks for root growth, they cannot support trees the way old stonewalls do. Thus, the SWTs have become our irreplaceable heritage. The SWTs are also different from ‘Wall trees’ which grow on walls such as free-standing walls, concrete walls or concrete walls with a stone facing, without roots penetrating the wall.

Do you know the key points to note when appreciating a SWT?



Although the SWTs are majestic, they are delicate due to their unique structural balance. Compared to their counterparts growing on the ground with soil, the SWTs' trunks are grown at an angle leaning towards the wall. With limited soil, their overall structural balance is very delicate. Also, as SWTs' roots could only grow into the cracks of the stonewalls and aft-soil, they grow much fewer roots for support than their counterparts. Moreover, stonewalls were not designed to bear the loads of trees. These altogether make the SWTs more vulnerable to wind and hence have a higher risk of failure. Therefore, while appreciating the SWTs, we should also be aware of their potential risks of failure and the need for close monitoring and management.

Some SWTs have collapsed after typhoons or inclement weather (see the case below). To prevent property damage and injuries caused by these destructive SWT failure events, proper SWT management is crucial.



## CASE

There is a limit as to what man can do, especially when compared to the power of nature. During super typhoon Mangkhut struck Hong Kong in 2018, a SWT close to the Duddell Street Steps collapsed under the strong wind, damaging three of the four century-old gas-powered street lamps in proximity, as well as part of the historical granite steps. Due to the SWTs' delicate structural equilibrium, their ability to withstand wind is often lower than that of their counterparts growing on ground. While preserving them is our mission, we should also be reminded of their potential risks of collapsing and our responsibility of ensuring public safety.

■ After typhoon Mangkhut's attack



## SWT AT DUDELL STREET

■ Before typhoon Mangkhut's attack



## HIGHWAYS DEPARTMENT'S MULTI-DISCIPLINARY APPROACH ON SWT MANAGEMENT

Highways Department (“HyD”) is responsible for managing and maintaining the largest number of SWTs among all government departments. As of August 2019, out of around 300 SWTs in Hong Kong managed by government departments, around half of them are under the HyD’s maintenance. To manage such a large number of SWTs, a systematic and comprehensive management plan is essential. Yet, the SWTs are unique - so unique that there is no international reference case of SWTs in compact cities with such high density available when formulating such plan. To ensure that this innovative strategy is well-grounded, the HyD has adopted a multi-disciplinary collaborative approach.

In October 2015, a multi-disciplinary SWT Working Group was formed in the HyD, comprised of the following divisions/units:

- Bridges & Structures Division
- Geotechnical Advisory Unit
- Landscape Division
- Research & Development Division
- Survey Division
- Urban Region (Hong Kong)

Members of the Working Group provide specialised support with a common goal of achieving proper SWT management. The HyD’s in-house professionals of diverse specialties empower the department in developing and implementing SWT management measures.

### RISK RATING ASSESSMENT APPROACH AND METHODOLOGY

The SWTs grow in harsh environment and stressful conditions. A SWT can fail on its own or fall down with the soil mass it retains due to instability or collapsing of the wall.



Drawing reference to international practice, a qualitative cum quantitative risk rating assessment system is developed to evaluate the risk of each SWT. As the extent and distribution of roots behind the wall cannot be ascertained, the stability of a SWT cannot be assessed simply by engineering methods. Therefore, as one of our SWT management actions, multi-perspective monitoring is implemented to help gain a thorough understanding of each SWT. Under this rating system, both the *consequences of failure* and the *likelihood of failure and the impact* are assessed. In order to rate and categorise all SWTs into four risk levels (low, moderate, high and extreme), each SWT needs to be assessed in a comprehensive manner.

## SWT MANAGEMENT ACTIONS: MULTI-PERSPECTIVE MONITORING

The HyD's landscape architects, apart from monitoring the SWTs closely together with arborists from our contractors, have also engaged tree experts to provide advice on medium and long term management plans. Regular inspections and Tree Risk Assessments are conducted for each SWT, following the guidelines published by the Development Bureau's Tree Management Office. Qualified professionals carry out assessments for the SWTs, at least twice a year, on their health conditions, pest problems and/or diseases, as well as the integrity of the tree structure. For details, please refer to the *Guidelines for Preservation and Maintenance of Stonewall Trees under Highways Department*.

Civil engineers, geotechnical engineers and our engineering staff also provide their engineering expertise through monitoring the integrity of the stonewalls and designing support systems.



■ Supervised tree inspection before pruning.



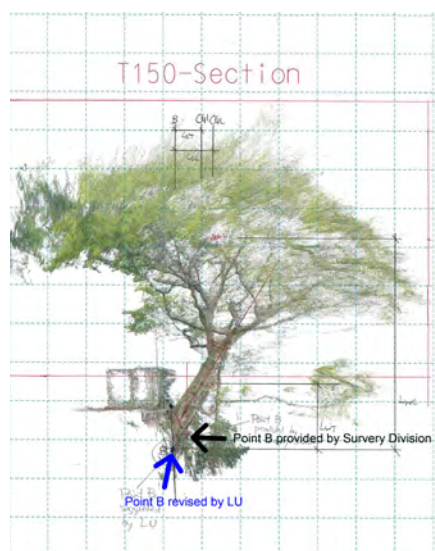
■ Tree inspection by various disciplines.

Monitoring survey on tree movement or displacement is also conducted by our land surveyors and survey officers. The position of multiple selected marks on tree trunk are surveyed periodically to detect tree displacement for early mitigating actions.

Close range photogrammetry and laser scanning survey are as well done to monitor our SWTs. After data processing, a 3D model could be generated for each SWT to facilitate further monitoring of canopy changes and planning of the extent of tree pruning. To ensure the stability of stonewalls, our surveyors also monitor the stonewall and its cracks, if any, for any changes.



■ Monitoring of SWT using total station by radiation method.



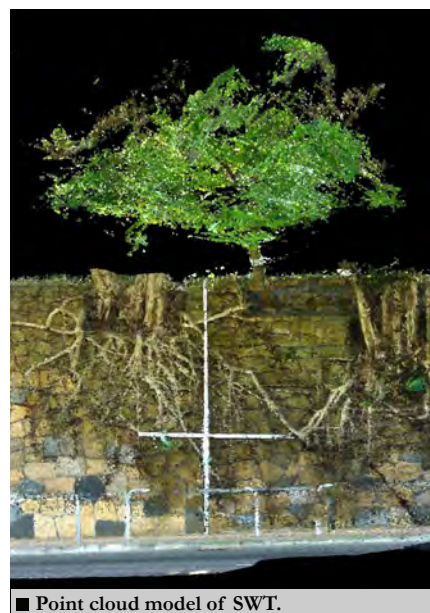
■ Cross-section of laser scanned SWT model.



■ Location of selected spots on tree trunk and stonewall to be surveyed.



■ Tree assessment with 3D point cloud model.



■ Point cloud model of SWT.

**SWT MANAGEMENT ACTIONS: COMPREHENSIVE MITIGATION**

After we have gained adequate understanding of the SWTs' condition through monitoring and assessing, mitigation actions to be undertaken for SWTs of different risk ratings include:

- Provision of support systems  
(in the form of supporting props, guying, cabling or aerial root guiding);
- Pruning;
- Creation of rooting areas at the crest of retaining walls;  
and
- Tree Removal.



■ Tree pruning works with LGS.

- Reducing and Balancing Load on SWT

As one of the means to alluviate the risks derived from the risk assessments, pruning is done to reduce the crown size and tree height, thus reducing the weight of the crown itself as well as the wind load acting on the tree. The extent of pruning is determined by the engineering analysis derived from the Tree Trunk Failure Analysis and Tree Anchorage Shallow Failure - Sensitivity Analysis.



■ Tree mitigation works by qualified tree climber for areas not accessible by machine.

- Strengthening and Maintaining SWT's Structure

External structural support could be provided to the SWTs. Methods include installation of supporting props, guying or cabling. The support of SWTs can also be enhanced by guiding aerial roots to the soil. Aerial roots of SWTs will lignify when they reach the ground and will gradually become tree trunks. The growing environment for roots could also be improved through expansion of the existing growing space. Protection of the existing SWTs and their roots from damage is also essential.



- Removing the Tree to Avoid Devastating Tree Failing Events

When no other measures are practicable in mitigating a SWT from its high risk of failure, removing the concerned tree would be the last resort. (See the Case below)

## CASE

## SWT AT LOWER ALBERT ROAD

A SWT on Lower Albert Road was under our constant monitoring. The changes in size of the cracks on the stonewall's top and surface have been monitored and recorded. Soon after Typhoon Mangkhut's attack in 2018, engineering staff noticed the significant enlargement of cracks on the stonewall near the base of the SWT on Lower Albert Road. Upon inspection, our multi-disciplinary team found that the SWT was in imminent danger of failure. As its failure would lead to catastrophic consequences and due to the lack of other practicable mitigating means, the team concluded that there was a need to arrange urgent removal of the SWT. The team then liaised with tree experts and the TMO to discuss on arboricultural works, and consulted the District Officers, the District Council and other stakeholders. Prompt arrangements were made in collaboration with the Police, the Transport Department and the contractor for the removal of SWT. The collaboration of different parties enables us to take timely actions to minimise risks facing the general public.



■ Significantly enlarged crack on stonewall crest after typhoon.



■ Crack on stonewall surface after typhoon Mangkhut's attack.



■ Crack on stonewall crest after typhoon Mangkhut's attack.



■ Emergency felling of SWT.

## CONCLUSION

It all started with an unintentionally placed seed. Then there was rain just enough for the seed to germinate and grow without being flushed away. The seedling's roots happened to find their ways through and into the gaps between the rubble stones that give them support. Perhaps, the probability for this series of coincidences could hardly be derived accurately. Yet, the SWTs are now being conserved by a group of multi-disciplinary professionals, working diligently to ensure public safety.

**REFERENCES**

- Greening, Landscape and Tree Management Section, Development Bureau (DEVB). (2013). Management Guidelines for Stonewall Trees. Retrieved June 17, 2019, from [https://www.greening.gov.hk/filemanager/content/pdf/tree\\_care/Guilelines\\_for\\_stone\\_wall\\_trees\\_e.pdf](https://www.greening.gov.hk/filemanager/content/pdf/tree_care/Guilelines_for_stone_wall_trees_e.pdf)
- Greening, Landscape and Tree Management Section, Development Bureau (DEVB). (2014). Management Guidelines for Mature Trees. Retrieved June 17, 2019, from [https://www.greening.gov.hk/filemanager/content/pdf/tree\\_care/Paper\\_Mature\\_Trees\\_\(finalised\\_and\\_issued\)\\_e.pdf](https://www.greening.gov.hk/filemanager/content/pdf/tree_care/Paper_Mature_Trees_(finalised_and_issued)_e.pdf)
- Greening, Landscape and Tree Management Section, Development Bureau (DEVB). (2015). Guidelines for Tree Risk Assessment and Management Arrangement (8th Edition). Retrieved June 17, 2019, from [https://www.greening.gov.hk/filemanager/content/pdf/tree\\_care/TRAM\\_2015\\_R8-Guidelines\\_for\\_TRAM\\_Arrangement.pdf](https://www.greening.gov.hk/filemanager/content/pdf/tree_care/TRAM_2015_R8-Guidelines_for_TRAM_Arrangement.pdf)
- Greening, Landscape and Tree Management Section, Development Bureau (DEVB). (2016). Handbook on Tree Management). Retrieved June 20, 2019, from [https://www.greening.gov.hk/en/tree\\_care/Handbook\\_on\\_Tree\\_Management.html](https://www.greening.gov.hk/en/tree_care/Handbook_on_Tree_Management.html)
- Greening, Landscape and Tree Management Section, Development Bureau (DEVB). (n.d.). Tree Register. Retrieved June 13, 2019, from <https://www.greening.gov.hk/treeregister/map/treeIndex.aspx>
- Highways Department (HyD). (2019). Guidelines for Preservation and Maintenance of Stonewall Trees under Highways Department.