

**Assessment Report on
Feasibility of Tree Support Systems proposed in
Study on Stonewall Trees on Slope no. 11SW-A/R577
Bonham Road, Hong Kong**

1. Background

1.1 Highways Department (HyD) is responsible for maintenance of vegetation growing on registered slopes (including stonewalls) belong to HyD. Some of these stone walls have trees growing directly on them, and may create risks to nearby residents or road users. In the case of slope no. 11SW-A/R577 between Bonham Road and St. Stephen's Lane (Figure 1.1), there are six stonewall trees growing on it and some signs of risks of root detachment and trunk cavity at trees T4 and T5 respectively can be observed. In view of the potential risks to public due to their close proximity to bus stop and busy traffic, HyD has invited Professor C Y JIM, a tree expert, to carry out a study to identify the factors affecting the health and stability of the stonewall trees, formulate suitable maintenance measures for their sustainable growth and advise on mitigation measures to minimize the risk of tree failure (the Study). The overall view of the trees is shown on Photo 1.1.

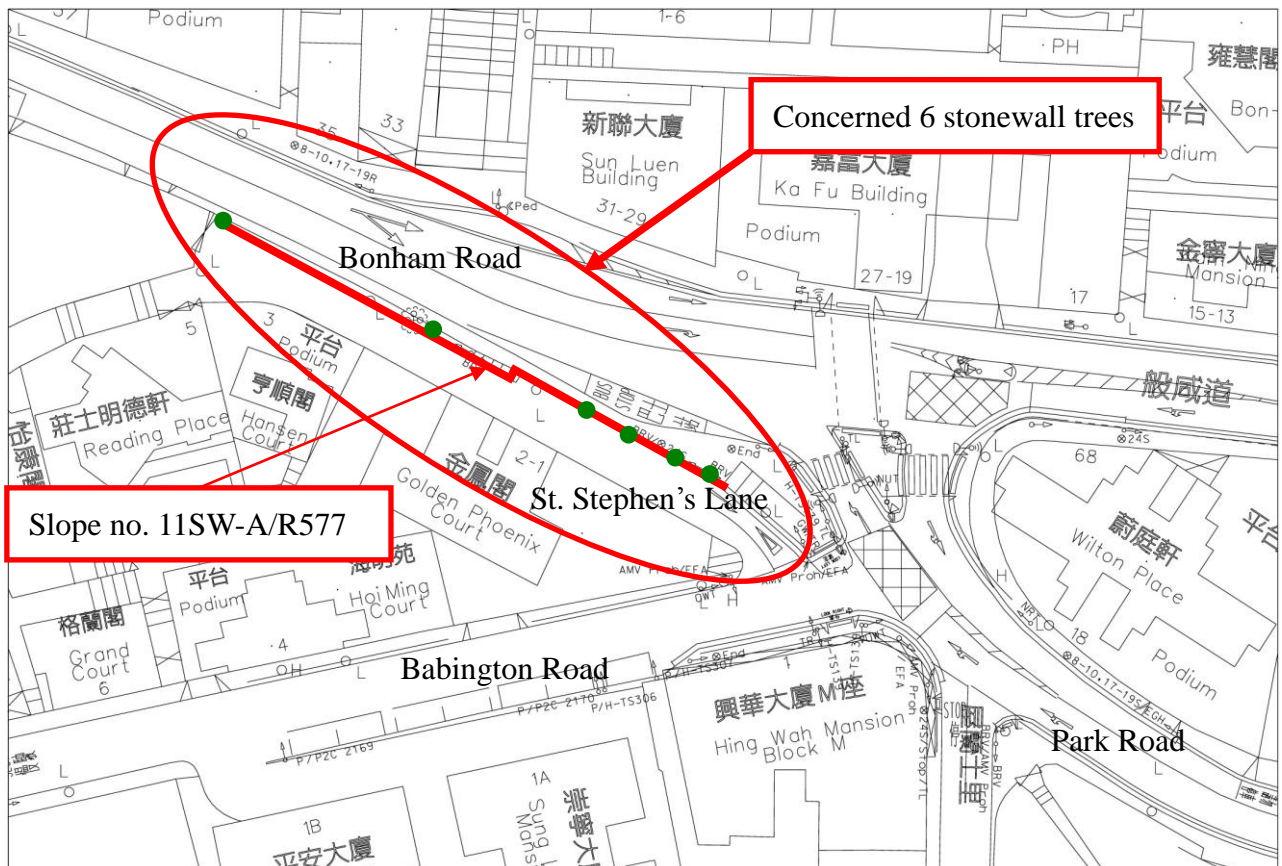


Figure 1.1: Location of the concerned stonewall trees

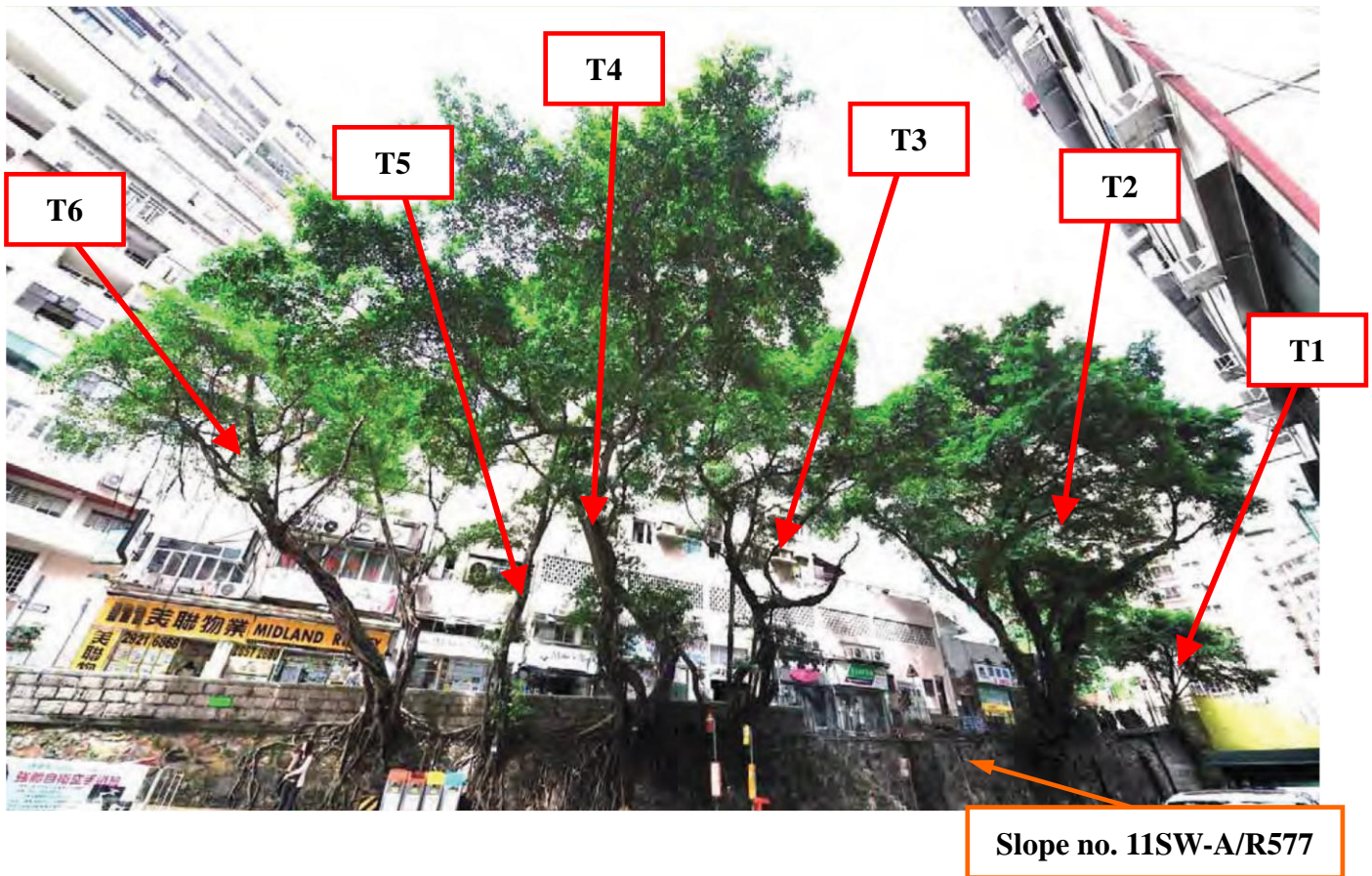


Photo 1.1 – Overall view of the 6 stonewall trees

1.2 The trees conditions as assessed in the Study are summarized as follows:

- (i) T1 – This is a small tree with little structural problem or decay problem. Tree hazard assessment has a score of 5 (see remarks below) and is rated as **low risk level**.
- (ii) T2 – This is an Old and Valuable Tree (OVT) with the Registered Number LCSD CW/14. The tree is generally in good health and has a well-formed scaffold. Tree hazard assessment has a score of 5 and is rated as **low risk level**.
- (iii) T3 – This is a semi-mature size tree with much confined scaffold development. Tree hazard assessment has a score of 5 and is rated as **low risk level**.
- (iv) T4 – This is a twin stemmed mature size tree which is the most tilted of the 6 stonewall trees at the site. The tree has low live crown ratio and incipient anchorage failure. Tree hazard assessment has a score of 9 and is rated as **medium risk level**. However, as the tree has one additional risk factor [root detachment from stonewall], it is therefore described as **alarming risk**.
- (v) T5 – This is a mature size tree with low live crown ratio, narrow & confined crown and

large cavity with decay at the trunk base. Tree hazard assessment has a score of 8 and is rated as **medium risk level**. However, as the tree has one additional risk factor [large trunk base cavity], it is therefore described as **alarming risk**.

- (vi) T6 – This is a twin stemmed mature size tree with heavy lean, asymmetrical crown. Tree hazard assessment has a score of 5 and is rated as **low risk level**.

Remarks: Risk score ranges from 3 – 12, from very low risk (score = 3) to high risk (score = 10-12)

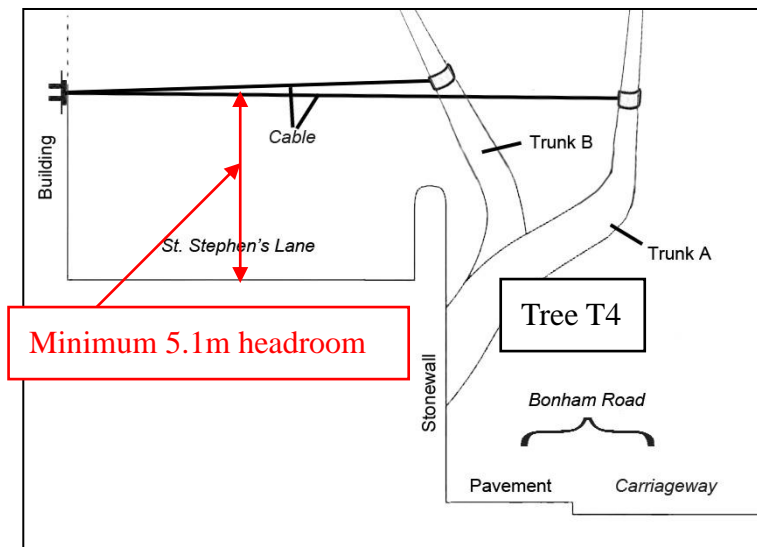
2. Deliberation on the proposed methods for supporting the concerned trees

2.1 As mentioned in paragraph 1.2 above, two of the stonewall trees, T4 and T5 are identified in the Study as having alarming risks. Four methods, namely Methods A to D are proposed in Professor JIM's study report to support the trees. Three other methods namely Methods E to G have also been included as alternatives for exploration in this report. The seven proposed methods for supporting the two concerned trees T4 and T5 are listed below and are examined in details in the ensuing paragraphs.

- (a) Method A: Cables anchor on structural member of a nearby building at St. Stephen's Lane
- (b) Method B: Cables tie-in on steel frame to be anchored at St. Stephen's Lane
- (c) Method C: Installation of supporting frame beneath the trees with supports at stonewall and Bonham Road pavement
- (d) Method D: Cables anchor at the crest of stonewall
- (e) Method E: Steel post support at Bonham Road southern footpath
- (f) Method F: To cover the bus stop and the section of footpath underneath the two concerned trees T4 and T5
- (g) Method G: Support by structural steel frame from opposite footpath at Bonham Road

2.2 Even though tree roots are currently providing resisting moment and support for the trees, we observe that there is tree root detachment for tree T4 and the situation may get worse. Therefore, in carrying out the following structural assessments, we will adopt a more prudent approach by assuming that the toppling moment due to dead weight of the trees and wind load is to be wholly resisted by the external supporting system. (i.e. the capacity of the tree roots in holding the trees is ignored.)

2.3 Method A: Cables anchor on structural member of a nearby building at St. Stephen's Lane



Sketch 2.1

2.3.1 Method A is considered infeasible for the following reasons:

- (i) There are no statutory powers for government authorities including HyD to anchor the cable system on private structure/building. The general view of nearby building is shown on Photo 2.1. As the building facade does not belong to individual owner, consents from owners' incorporation or all building owners are required. However, there is no incentive for the building owners to agree the installation of cables on their building. Furthermore, as extra loading due to cable anchorage will be applied on the building, the liability and maintenance issues are difficult to be resolved. The works will also affect and limit future maintenance of building facade and redevelopment of the building.
- (ii) Even if agreement can be obtained from the owners, the anchorage of the proposed cable bracing system will have to be provided at the facade of the common podium of the nearby Golden Phoenix Building to avoid potential structural and visual impact to individual residential units. With this cable supporting system, large tension force (in the order of 30 tonnes for T4 and 4 tonnes for T5) will then be induced in the cables to support or stabilise the tree due to the dead weight of the tree and wind loads acting on the tree. There can be detrimental damage to the adjacent buildings and severe injury to the public caused by the immense destructive force from the failure of trees/branches/cables and associated parts during typhoon or strong gust/monsoon wind. It is estimated that two anchorage plates of 550mm x 550 mm size with four 24mm diameter high tensile strength bolts anchoring 210mm in the building are required (with at least 270mm thick concrete being required to hold the bolts). However, as the building is quite old, the condition of concrete is uncertain. Moreover, the estimated wall thickness is only 250mm (Photo 2.3). Therefore the suitability of the anchorage is in doubt. The anchorage depth of 210mm

would also affect the existing reinforcements inside structural members of the building.

- (iii) As a minimum headroom¹ of 5.1m has to be maintained at St. Stephen's Lane for vehicular traffic, the cables should be mounted at a high position of the tree where the tree branches may not be strong enough to take the high tension forces. (Photo 2.2)
- (iv) The structural stability of the building will be affected due to the extra loading from the cable system which has not been allowed for in the original design of the building. The stability of the building is required to be reassessed and strengthening works on the building will probably be required. Submission to Buildings Department for their approval is also required for the proposed works and it will take considerable time for the required processes while the public is being exposed to the risk of tree failure.



Photo 2.1 – General view of nearby building



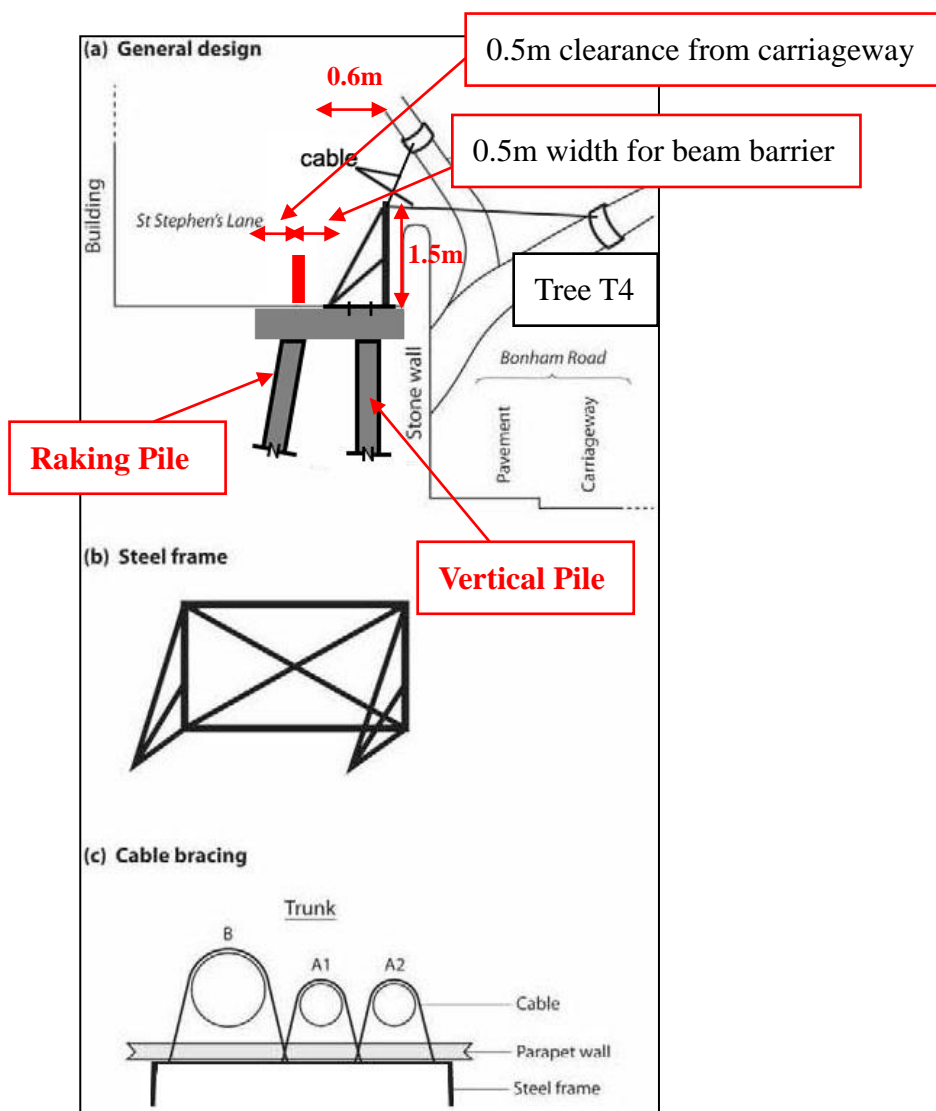
Photo 2.2 – Proposed cables anchor on the nearby building

¹ Transport Planning and Design Manual Volume 2 Chapter 3 Paragraph 3.5.1.3



Photo 2.3 – Existing condition of nearby building

2.4 Method B: Cables tie-in on steel frame to be anchored at St. Stephen's Lane



Sketch 2.2

2.4.1 Method B is considered infeasible for the following reasons:

- (i) St. Stephen's Lane is a one-lane two-way carriageway of about 4.5m width, being shared use with pedestrians. The existing road width is not up to current standard due to site constraints. The road width at the location of Tree T4 and T5 are 4.25m and 4.50m respectively. As the absolute minimum carriageway width requirement for a single track access road serving as emergency access² is 3.5m and the horizontal clearance requirements for carriageway to building/structure/obstruction³ is 0.5m on each side, the existing road width is already below or at the minimum standard. It is not viable to install any structures at St. Stephen's Lane due to the road width constraint. (Photo 2.4)
- (ii) The estimated size of the supporting frame would be 0.6m in width perpendicular to the parapet wall. With 0.5m width allowed for erecting a beam barrier to protect the frame and 0.5m clearance from the barrier to edge of carriageway, the structure will occupy 1.6m road width at least. Even the widest section of St. Stephen Lane (about 5m) cannot provide the required road space for the proposed structure because a minimum clear road width of 3.5m as mentioned in (i) above is required.
- (iii) Due to leverage effect, a large force (in the order of 85 tonnes for T4, and 15 tonnes for T5) will be induced in the cables in order to support or stabilise the tree due to its dead weight and wind loads acting on the tree. As the supporting frame is to be installed close to the top of the stonewall, the transfer of extra loading to the crest of the stonewall will create extra overturning moment and lateral force on the stonewall. Additional stonewall strengthening such as provision of soil nails into the soil strata behind the stonewall around the tree is required to ensure that the masonry wall itself is stable. However, substantial works in close vicinity of the stonewall trees will damage the tree roots and adversely affect the stability of the stonewall trees. The damaged tree roots would be susceptible to fungal infection which will further affect the health and stability of the stonewall trees, thus defeating the purpose of remedial measure.
- (iv) To avoid transferring extra loading to the crest of the stonewall, the foundation of the steel frame for supporting the tree has been preliminarily assessed to take the form of seven mini-piles (three vertical and four raking piles) at St. Stephen's Lane in order to tie the steel frame firmly onto the ground. The vertical piles would certainly hit the masonry blocks behind the stonewall. To resist the estimated lateral and pulling force, the raking piles would also extend across the lane and encroach into the building lot boundary, hitting the building foundation. The scheme is therefore considered infeasible. Moreover, the tree roots growing under the St. Stephen's Lane behind the masonry wall will be damaged

² Transport Planning and Design Manual Volume 2 Chapter 3 Paragraph 3.11.7.1

³ Transport Planning and Design Manual Volume 2 Chapter 3 Paragraph 3.5.2.1

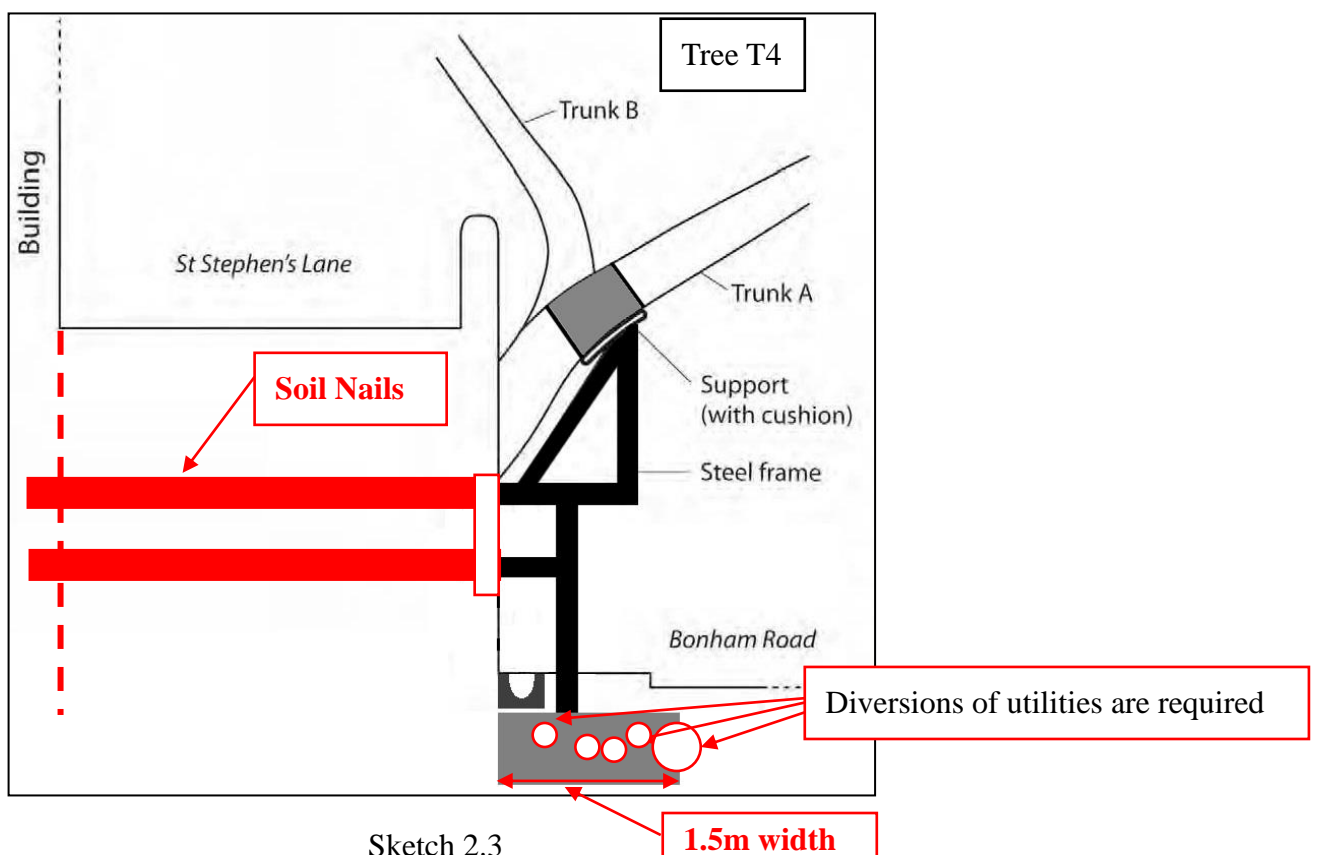
and the masonry wall structures will also be adversely affected due to the piling works.

- (v) In addition, according to the utility records, there are at least two numbers of underground electricity cables located at the St. Stephen's Lane. Underground utility diversion will result in closure of the whole lane for a long period. Together with the supporting frame construction works, St. Stephen Lane will have to be closed for prolonged period which is unacceptable as the lane serves as emergency vehicular access to adjacent buildings.



Photo 2.4 – St. Stephen Lane

2.5 Method C: Installation of supporting frame beneath the trees with supports at stonewall and Bonham Road pavement



Sketch 2.3

2.5.1 Method C is considered infeasible for the following reasons:

- (i) From our survey, the lower part of the tree is only 2.5m above the existing footpath at Bonham Road. The estimated size of the supporting beams is 0.3m in depth. As such, minimum headroom of 2.3m for footpath cannot be maintained if the supporting frame is to be constructed on the masonry wall adjacent to the footpath. (Photo 2.5)

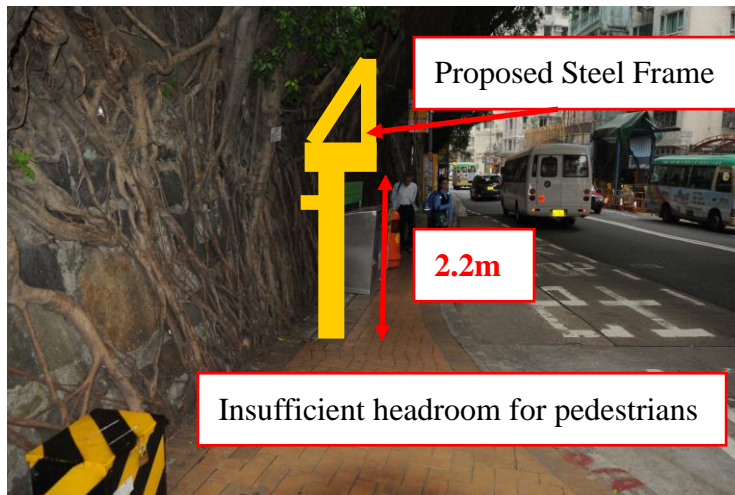
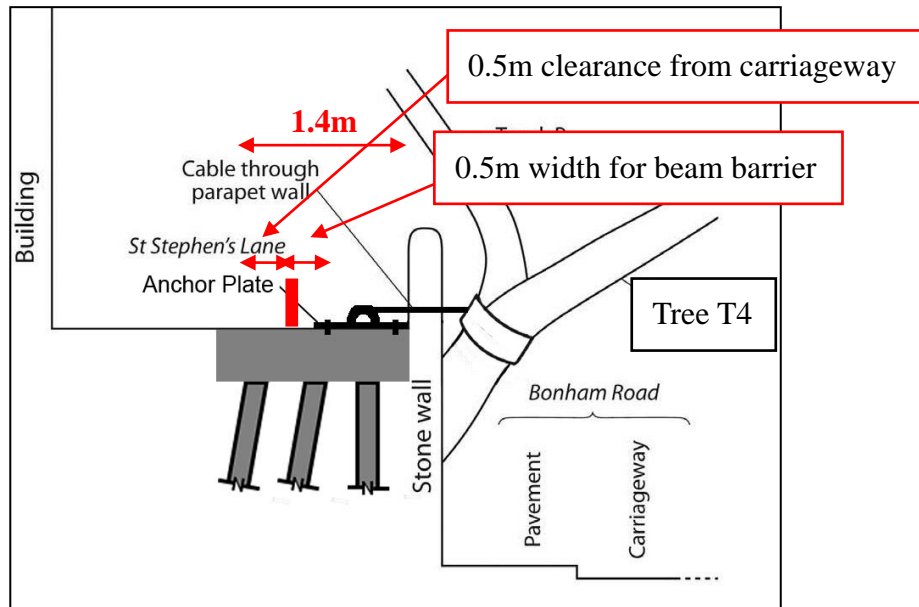


Photo 2.5 – Southern footpath at Bonham Road (viewing from the east)

- (ii) Similar to Method B, the proposed structure (steel frame) will induce extra loading and overturning moment onto the stonewall. To provide the restoring force, installation of two layers of soil nails with 6m long under and across St. Stephen Lane is required. However, the soil nails will hit the foundation of the nearby building and is therefore impractical. Diversion for underground electric cables at St. Stephen Lane, which are expected to be buried at depth greater than 900mm, may also be required. (See also Method B, para. 2.4.1 (iii) and (v).)
- (iii) In addition, the supporting frame will have to stand on the narrow southern footpath of Bonham Road with a foundation of about 1.5m x 1.5m in size. According to the utility records, there are underground utilities such as drainage pipes, electricity cables, gas pipes located at the section of the footpath. Underground utilities also exist at the opposite footpath so that the space available to accommodate utilities diverted from the southern footpath is limited. Underground utilities diversion to provide space for the supporting frame will result in closure of traffic lane at Bonham Road for a long period and will cause serious traffic disruption.
- (iv) The stonewall trees are fronting directly above the busy bus stop on Bonham Road.

Relocation of bus stop and cancellation of bus lay-by to free more space for the proposed works has also been considered. However, as advised by Transport Department (TD), there is no alternative lay-by along Bonham Road (westbound) for the bus stop relocation. Without the bus lay-by, on-street picking-up/dropping-off of passengers on Bonham Road will severely disrupt traffic flow in the area. TD and the locals will not support the proposal of relocating the bus stop.

2.6 Method D: Cables anchor at the crest of stonewall



Sketch 2.4

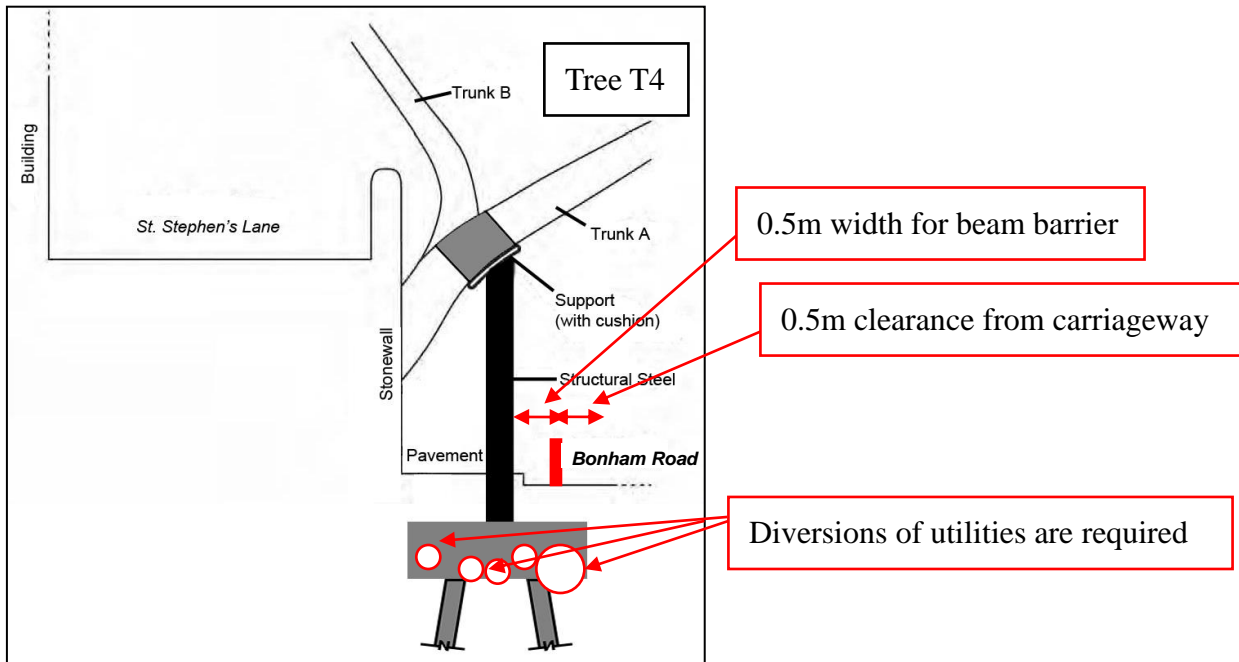
2.6.1 Method D is considered infeasible for the following reasons:

- (i) The estimated size of the anchor plate is 0.4m in width. With 0.5m width allowed for beam barrier to protect the plate and cable and 0.5m clearance from the barrier to edge of carriage way, the structure will occupy 1.4m road width at least. However, as mentioned above, there is insufficient road space at St. Stephen Lane to provide the required road width.
- (ii) Moreover, any transfer of extra loading to the crest of the stonewall will create extra overturning moment and lateral force on the stonewall. Additional stonewall strengthening works will be required. (See also Method B, para. 2.4.1(iii).)
- (iii) Owing to low anchorage point, the overturning moment of the dead load and wind load of the stonewall tree will create a very large tension force on the cables (in the order of 260 tonnes for T4 and 42 tonnes for T5). The foundation of the structure would be in the form of eighteen mini-piles (twelve raking and six vertical piles) at St. Stephen's Lane to

provide the required lateral resistance. The raking piles would hit the foundation of the nearby building and make the scheme infeasible. (See also Method B, para. 2.4.1(iv).)

- (iv) In addition, diversion for underground electric cables at St. Stephen Lane is required. (See also Method B, para. 2.4.1(v).)

2.7 Method E: Steel post support at Bonham Road southern footpath



Sketch 2.5

2.7.1 This method is considered infeasible for the following reasons:

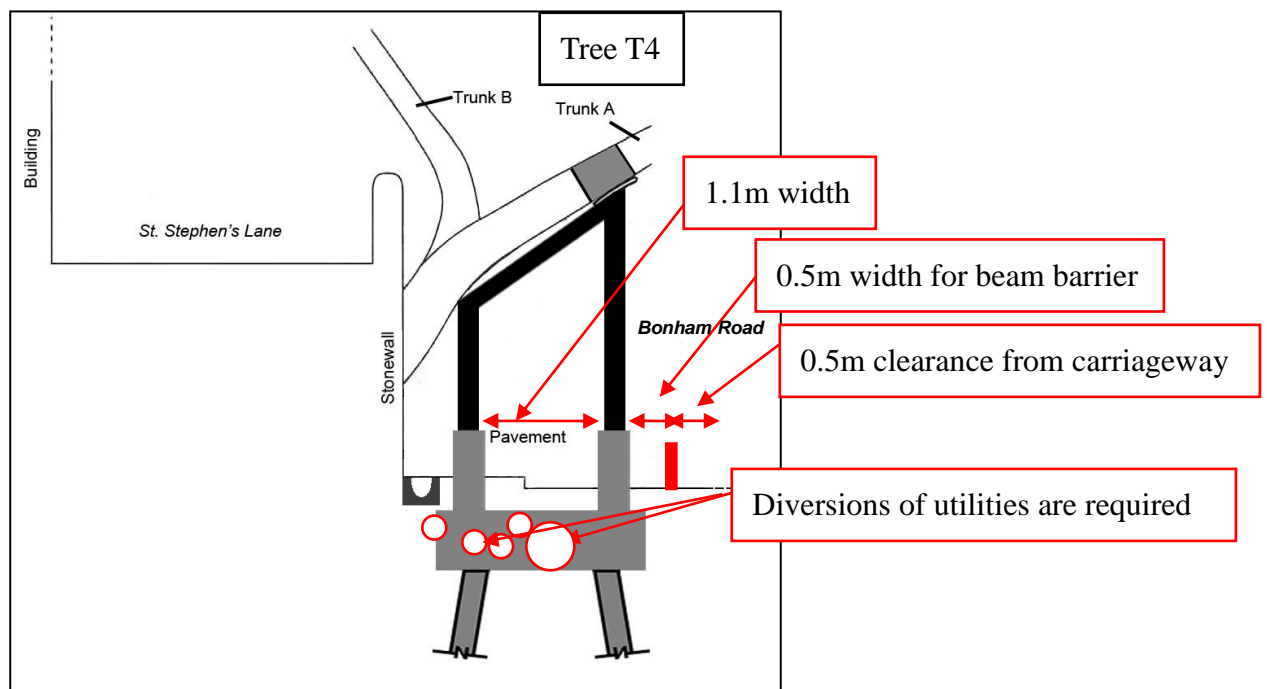
- (i) The existing footpath width near tree T4 and T5 is only 1.23m (Photo 2.6) which is not up to current standard. It is already too narrow to accommodate both pedestrians and passengers waiting at the bus stop. The construction of structures occupying extra footpath spaces is therefore impractical.
- (ii) Relocation of bus stop and cancellation of bus lay-by to free more space for the proposed works has also been considered but impractical. (See also Method C, para. 2.5.1(iv).)
- (iii) Large supporting moment (in the order of 2300KNm for T4 and 360KNm for T5) to support or stabilise the trees by the steel pole and foundation is required to counterbalance the bending moment induced from the dead weight of the tree and wind loads acting on the tree. The foundation of the steel structure in the form of four raking mini-piles is required. The pile cap size will be in the size of 2.5m x 2.5m. Diversions of utilities at

the southern footpath of Bonham Road are required. (See also Method C, para. 2.5.1(iii).)



Photo 2.6 – Southern footpath at Bonham Road (viewing from the west)

2.8 Method F: To cover the bus stop and the section of footpath underneath the two concerned trees T4 and T5

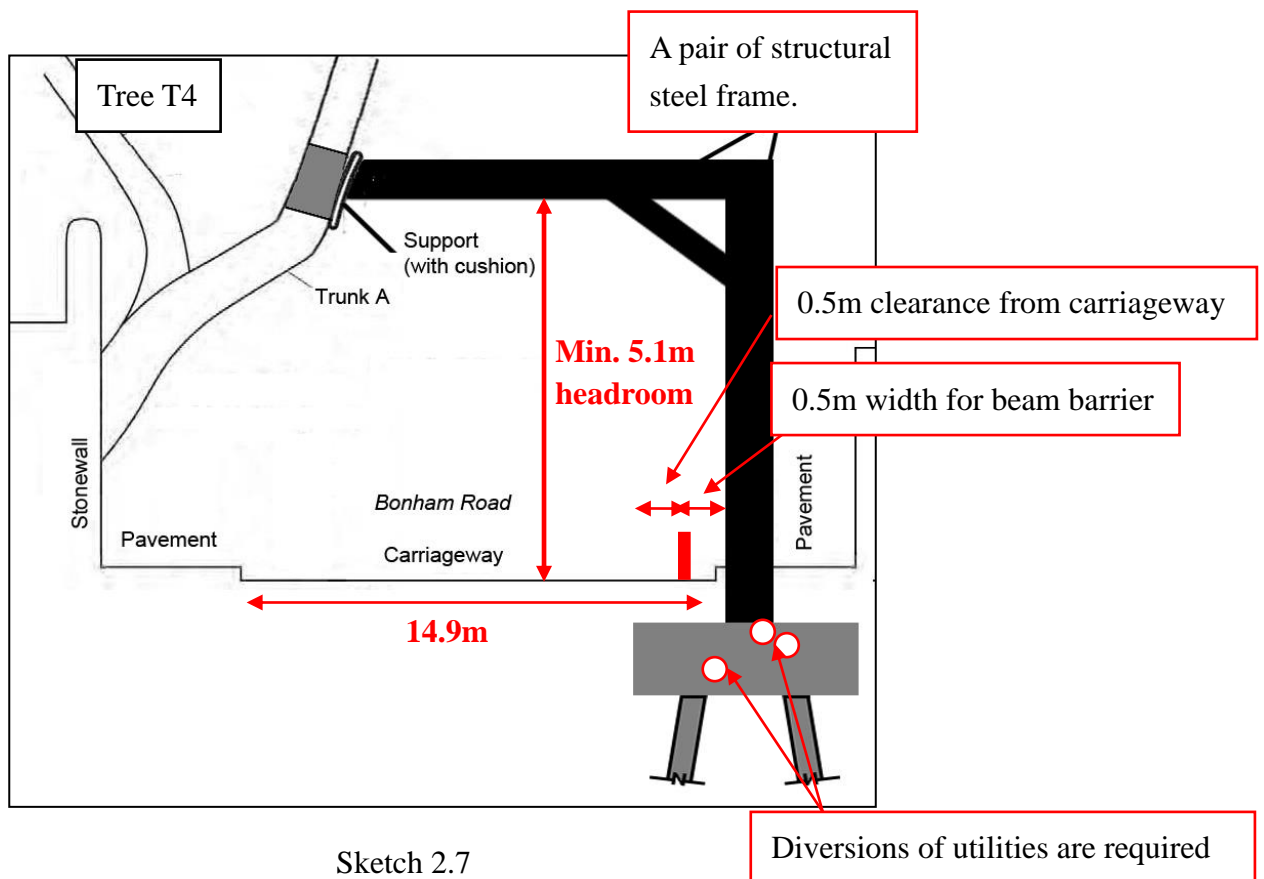


Sketch 2.6

2.8.1 This method is considered infeasible for the following reasons:

- (i) The existing footpath width near tree T4 and T5 is only 1.23m. (See also Method E, para. 2.7.1(i).)
- (ii) If the bus stop could be relocated, an additional road width of about 2.4m might be available. With the provision of beam barrier and 0.5m clearance from the carriageway, the remaining road width for pedestrians is only 1.1m (Sketch 2.6) at most which is undesirable. Most importantly, the relocation of the bus stop is impractical. (See also Method C, para. 2.5.1(iv).)
- (iii) Diversions of utilities at the southern footpath of Bonham Road are required. (See also Method C, para. 2.5.1(iii).)

2.9 Method G: Support by structural steel frame from opposite footpath at Bonham Road



2.9.1 This method is considered infeasible for the following reasons:

- (i) As the proposed structure will span over the carriageway of 14.9m width, the bending

moment (in the order of 7000KNm for T4 and 1400KNm for T5) and torque (in the order of 5700KNm for T4 and 850KNm for T5) induced on the structure will be very large and the structure members will be very massive.

- (ii) The footpath at the opposite side is 2.7m wide only. In addition, the existing canopy of Sun Luen Building will obstruct the steel structure (Photo 2.7). With the 0.5m clearance requirement from the carriageway and 0.5m width for beam barrier, there is insufficient footpath space to accommodate the massive structure steel post (about 1m width steel post).
- (iii) Large supporting moment (in the order of 7000KNm for T4 and 1400KNm for T5) to support or stabilise the trees by the steel pole and foundation is required to counterbalance the bending moment induced from the dead weight of the trees and wind loads acting on the trees. The long cantilever arm also induces very large bending moment and torsion. The foundation of the steel structure has been preliminarily assessed to take the form of six raking mini-piles. The pile cap is in the order of 3.7m x 4.7m. According to the utility records, there are underground utilities with at least one drainage pipe, one water pipe, and one gas pipe located at the northern footpath of Bonham Road. Underground utilities also exist at the opposite footpath so that the space available for utility diversion is limited. Underground utilities diversion will result in closure of traffic lane at Bonham Road for a long period and will cause serious traffic disruption.
- (iv) The proposed massive structure will cause unacceptable adverse visual impact.



Photo 2.7 – Northern footpath at Bonham Road

3. Conclusion

- 3.1 All probable options, in particular those recommended in Prof. JIM's study, for preservation of the concerned trees T4 and T5 have been thoroughly looked into. However, owing to the extremely constrained site conditions, there is no viable scheme for supporting the concerned trees T4 and T5.
- 3.2 Other abatement measures including (i) restricting access/cordon off the area within the possible tree fall zone; (ii) removal or relocating the potential target/objects that may be hit by the fallen trees; and (iii) pruning have also been considered. The first two abatement measures are undoubtedly not feasible in view of the busy vehicular and pedestrian traffic which cannot be cordoned off and the existence of bus stop, residential buildings and shops which cannot be relocated. Besides, the existing live crown ratios of the concerned trees T4 and T5 are already low and very low respectively providing little scope for further pruning. More fundamentally, such pruning which may only provide limited reduction in dead weight and wind load of the trees cannot fundamentally address the significant risks posed to public as alarmed by the sign of root detachment of T4 and the large trunk cavity of T5.
- 3.3 In view of the fact that the alarming risk of the trees, which would endanger pedestrians and traffic on Bonham Road and nearby properties, cannot be mitigated, the removal of the problematic trees is the last option and inevitable. This could also help to alleviate the pressures on the stonewall and would therefore in a way help to maintain its stability for the remaining stonewall trees.

4. Recommendation

- 4.1 In view of the significant risk to public safety and in accordance with the general advice promulgated by DEVB⁴, the trees T4 and T5 are recommended to be felled as soon as possible before the onset of typhoon season in May this year, as well as to follow the requirement of prompt action for the completion of necessary action to remove the identified risks of problematic trees.

Highways Department
April 2013

⁴ Secretary for Development's memo of 8 April 2013 referenced DEVB(GLTM) 200/2/3