Abstract of thesis entitled

Measurement and prediction of uproot stability of urban trees in Hong Kong

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Urban tree stability is an issue of wide concern in Hong Kong after several fatal tree failure accidents. Uprooting failure is usually unpredictable because the underground root structures cannot be visualized and inspected directly. To prevent tree failure accidents and enhance the accountability of tree risk mitigation measures, a quantitative assessment method to measure and predict tree uproot stability is urgently needed. A set of experimental procedures are proposed to quantitatively evaluate the uproot resistance and wind load acting on trees, information which is crucial for urban tree stability assessment.

Ground penetrating radar (GPR) detects the size and location of underground objects that have different dielectric permittivity from the surrounding materials. It might be a potential tool for root anchorage prediction and its performance in root detection in local conditions was examined. A soil bed with root segments buried inside was constructed to test the detection limitations of a 900−MHz GPR antenna. The soil water content, soil compaction, root thickness and location were manipulated. The 900−MHz antenna was able to identify roots that had diameters larger than 11 mm, had an inter-root distance larger than 0.1 m and were embedded less than 0.5 m belowground. Lower root water content decreased the detection quality. The results showed that GPR is useful for detecting main roots and preventing root damage from construction work. However, it might not be suitable for estimating root architecture and thus uproot resistance.

To measure the uproot resistance of trees, lateral pulling tests were conducted on two common tree species, *Schefflera heptaphylla* and *Acacia confusa*. Trees were pulled laterally while the applied load and stem base rotation were recorded

continuously. The strength of uproot resistance was expressed as the maximum turning moment about the stem base. The threshold of elastic stem base rotation was investigated by loading−unloading tests, with increased loads applied at each consecutive cycle. The results demonstrated the existence of elastic rotation in the two species. The turning moment at the rotation angle within the elastic limit is highly correlated with the maximum turning moment. The aboveground tree characteristics were measured and regression analysis showed that maximum turning moment was best correlated with stem diameter at breast height. Besides, the maximum turning moment is highly correlated to the turning moment evaluated at 2° tree deflection.

Disturbing loads of wind acting on trees were evaluated by a customised telemetric monitoring system for three *Sterculia lanceolata* growing in a typical urban park. During typhoon events, wind speed, wind direction and tree deflection were measured and collected through a wireless connection. The drag coefficient as a function of wind speeds was evaluated and used to estimate the wind-induced turning moment. The monitored typhoons did not uproot any tree specimens but they did induce stem base rotation exceeding the elastic limit of one tree.

The research demonstrated that the proposed procedures are applicable for developing a monitoring system for wind load estimation and uproot stability assessment. Improvements and further investigation work for applying these methods in tree stability assessment are discussed.