FEATURE

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Figure 1: Illustration of a plastic crate system tree pit accommodating substantial soil volume and underground utility. Credit: GreenBlue Urban Ltd.

RIGHT TREE RIGHT INFRASTRUCTURE

Dean Bell, Associate member and PhD Researcher in the Centre for Sustainable Planning and Environments at the University of the West of England, outlines alternative approaches to urban tree pit design.

It was once put to me by an ex-colleague that urban tree professionals are designing "concrete coffins" in order to integrate trees into paved urban environments. They were in essence indicating that conventional approaches to urban tree pit design are driving high mortality rates across urban forests. There is some justifiable logic to this claim. However, the term 'conventional', and thus the approaches to tree pit design, vary considerably among those responsible for their delivery. This article summarises some of the challenges of urban tree establishment in hard landscapes and introduces technical solutions that may increase tree survival.

Urban forests, defined here as 'all the trees in the urban realm', play a pivotal role in maintaining healthy, sustainable communities and mitigating some of the negative impacts of urbanisation. The benefits of incorporating trees into the urban fabric has been the subject of considerable academic literature in recent years, demonstrating that well-maintained urban forests provide an array of ecosystem services (Davies et al., 2017; references therein).

The recent recognition of the benefits of urban trees has sparked a number of new national and local planting schemes across the UK. Examples are the Northern Forest and the current government's commitment to plant one million urban trees. Similarly, recent declarations of climate emergencies by local authorities have in many cases come with pledges to plant a significant number of trees. Whilst these are well received, there are concerns that planting pledges may be favouring 'fashion' over 'function', as tree growth and survival are often compromised in the built environment, where conditions are much less favourable than for their rural counterparts.

Establishing trees in hard landscapes presents significant technical challenges. Trees experience a litany of physical stresses that can pose profound threats to their biology, especially if exposure is routine. Examples include soil compaction, water deficits and nutrient deficiency. Either singularly, or cumulatively (as is typical), these harsh conditions are significant contributors to high urban tree mortality rates (Hilbert et al., 2019).

High tree failure was first highlighted in the 1980s where 30% mortality was recurrently recorded (Gilbertson and Bradshaw, 1985). However, more recent indications suggest mortality rates of 30-50% are commonplace within the initial year after planting (Hirons and Percival, 2012). Although the reasons for this are complex, perhaps the most significant threat to urban tree survival is the scarcity of soil suitable for root growth. Soil volume is a critical element for the success, or failure, of urban trees – the provision of an adequate rooting environment is essential to achieving canopy potential (Sanders and Grabosky, 2014).

The reality is that there are many inherent conflicts involved in establishing urban trees in hard landscapes. First, street and highway design results in significant competition for space. Securing adequate soil volumes for tree pits is a substantial and ongoing challenge. Second, highway construction standards require trees to navigate a landscape below ground constructed to a highly engineered specification. This is almost exclusively designed to restrict root growth.

In order for trees and infrastructure to coexist in modern urban conditions, tree pit design in hard landscapes must invariably serve a dual purpose: to provide both a soil environment that does not detrimentally limit root growth and a load bearing capacity conforming to engineering specifications. This balance is fundamental, as the soil environment to support urban tree growth is in direct contrast to the characteristics sought in highway design.

Highways are constructed as a layered system where soils, as an engineering substrate, are typically compacted to within 95% of their peak bulk density and base layers comprise a series of unbound granular materials that enable high compaction and rapid drainage. Whereas to optimise root growth, requirements include uncompacted soil with good aeriation and appropriate drainage, and fertility to provide a sustained nutrient resource. This requires a distribution of pore sizes and thus a well-structured and aggregated soil. While several adverse conditions for urban trees can be overcome by the selection of species tolerant of given challenges, there are relatively few species that could thrive within the soil densities specified for highway construction.

Fortunately, a suite of engineered tree pit solutions have been developed that accommodate the biotic aspects for root growth whilst supporting highway design loads. The leading solutions comprise structural growing media and crate systems. Structural growing media are load bearing substrates achieved through a skeleton of larger mineral particles such as sand or aggregate, whereas crate systems are high strength modular structural cells formed from plastic or concrete that protect the root system and act as a vault to support a large volume of uncompacted soil (Figure 1).

My PhD research investigates the impact of these solutions on urban tree survival, growth and physiological functioning, the delivery of a range of ecosystem services and examines whether the solutions can support the diversification of UK urban forests.

Simply put, trees are forest plants. They did not evolve in asphalt. Many cities have very ambitious targets to increase tree canopy cover, including my residing city of Bristol, which hopes to double the cover by the end of 2045. If we are to achieve these targets, a sustainable, multidisciplinary approach to urban tree pit design is essential, to mitigate high levels of maintenance incurred from poor tree establishment and to promote tree survival in hard landscapes.

Realising the many benefits delivered by urban trees depends on their survival, and trees must reach their species potential at maturity to optimise delivery. The mantra of 'right tree, right place' is embedded in a tree professional's practice. I would also add the need to focus on tree pit design, including the use of engineered solutions where appropriate – to aid successful establishment and promote the delivery of benefits for which urban trees are planted. Ultimately, I believe it is time to alter 'right tree, right place' to 'right tree, right place, right infrastructure'.

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Credit: GreenBlue Urban Ltd.