

| By Dave Dockter

A Green Building Technique for Infrastructure Planning

Structured soils allow trees to co-exist within the urban community.

Landscape designers, engineers and cities who approve development projects are confronted with hard-choice challenges of integrating trees and pavement – the merging of structural and horticultural needs for the urban environment. As cities place more emphasis on approving designs that have real components of project sustainability, many General Plans are currently being updated to reflect this emphasis of sustainability.

Simply put, the goal is to provide the longest return for the construction investment by the owner (community residents) and the design team (community officials). These and other challenges that face today's professional are becoming increasingly important. The professional must now face head-on the integration of sustainable and smart growth concepts into projects. Because trees are an intrinsic component of project landscape plans, the

project teams are wise to consider such a tool as engineered structural soil for certain applications.

Sustainable Green Building Practices

Sustainability may be defined as the industry working to promote infrastructure and landscapes in a way that is environmentally responsible, profitable and contributes to healthy places to live and work. On a daily basis, planners and architects are adding alternatives to their quiver of best management practices (BMPs) and green materials list. Sustainability, in the context of our landscape design and urban forest, reaches outside the boundary of merely buildings and structures. In time, LEED ratings will include stronger emphasis on the contribution of landscape infrastructure standards. LEED™, the “Leadership in Energy & Environmental Design”

Green Building Rating System, is a nationally accepted standard for green buildings developed by the US Green Building Council¹.

Sustainability using engineered structural soil mix technology for tree planting has been in use for some time. It is superior to the traditional standard in that tree resources are conserved longer, operating costs are reduced and the strain on local infrastructure is minimized. Thus, the soil mix product produces benefits in three primary areas: environmental, economic and community benefits. Trees planted in conventional tree pits contrast this.

Conventional Tree Pits Are Designed for Failure

A tree canopy will only grow as large as the roots enable it to grow. Limited rooting area directly limits the crown size, to wit, the bonsai effect.



This Caltrain underpass connects bicyclists and pedestrians to downtown Palo Alto from El Camino Real. The project was constrained by unique and challenging factors — protection of heritage oaks, critical screening requirements and tight working conditions beneath railroad and street right-of-ways. Hidden within the interesting geometric architecture, the Homer Tunnel project incorporated a unique green building technique, engineered structured soil, which gives the shade trees a limitless jump-start to health and to avert infrastructure damage caused by tree roots. The concrete wearing surface will realize an extended service life. The City also used next-generation concepts by applying a tree technical manual for protecting and enhancing tree resources. Both of these cutting edge methods are available for technology transfer to other agencies at: <http://www.city.palo-alto.ca.us/trees/technical-manual.html> (Photo courtesy of Palo Alto Public Works Dept).

The conventional tree pit typically used by civil engineering standards do not foster root-growing medium but, instead, emphasize only compaction-based infrastructure. Planting trees in these situations will incur sidewalk damage that is well documented.

Due to structural demands for pavements and flatwork, the soil volume for a landscape tree is typically reduced to confined small strips or islands. Planting details typically do not address soil outside of the pit. Soil outside the planter area is compacted too dense for roots to penetrate. The result is that most urban trees either become root bound with a stunted crown and/or eventually heave the surface from the roots expanding. Thus, conventional designs of the past dictate the high future costs and marginal benefits back to the community.

Designing with the Future in Mind

Urban designers are using this green building technique to provide a solution for tree/infrastructure issues. The mix provides load-bearing capacity needed to support pavements and flatwork and the root growth/penetration needed by trees. It is a stone matrix blend of coarse aggregate, amended clay loam and hydrogel, proportioned so that when compacted in-place; the aggregate is in a dense state but the soil within the stone matrix is not over-compacted. The desirable potential is long-term benefits from tree growth, health and life expectancy and reduced movement, failures, and maintenance costs for adjacent pavements and flatwork.

Using this medium is particularly suitable for new construction projects. Depth of the engineered soil

mix appears to require excavating the subsoil a minimum of 24-inches deep and as wide as necessary for the engineered soil mix. The length and width of the below-grade trench is defined by what makes sense and which is available for use. In any event, in doing so, you will have provided for the trees an extraordinary increase in root growing volume, thereby increasing the above ground crown size potential and below ground health and longevity.

Considering a Project Site

The mix is not appropriate everywhere, as in a 'one size fits all' specification. Projects most suitable for using the mix are those that include areas that must be compacted for flatwork or paving and must also plant new trees adjacent to that area. Open landscape areas may remain native soil, as there is no need to compact these areas. Irrigation lines

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are laid after installing the mix and before the flatwork is applied. Again, the structural soil technique is particularly suited for new construction projects. It is impractical for retrofitting around mature trees because of the difficulties of excavating the existing soil and re-spreading the mix among the roots without damage. Retrofitting, as experienced by a Stanford University project² over the established root systems of a large coast live oak, is labor-intensive, difficult to specify in construction documents and requires hands-on oversight by trained staff and decision-makers.

For each community taking steps to implement sustainable designs, there always needs to be a first step or a benchmark project. The author advises to get a pilot project going using the mix to familiarize staff with the steps involved with its use – either as a city- or a privately-funded project.

As a capital improvement project, one section of sidewalk with trees or a new cul-de-sac development with new street tree planting would be prime. Or, as is most common, a privately funded development would be directed to implement use of the technique when approved by the reviewing body.

The designers may choose to specify structural soil in a section of parking area adjacent to trees in islands. This may be either initiated at the city's request of the applicant's architect; or by the applicant's architect submittal to the city for review and approval. In either case, once approved, using structural soil is an important step towards sustainability and 'win-win' message worthy of positive public relations recognition.

The pilot project in Palo Alto (CA) occasioned invitations to city council members and other interested persons to observe the innovative technique and became an occasion for lots of pat-on-the-backs, recognition for environmental sustainability and positive news media coverage.

History of the Engineered Mix, Construction and Costs

While it will always be an important point for someone to be advocating the use of the mix for a specific project design, it is equally important that the approving engineers know that many of their colleagues are satisfied with using the structural mix and have signed-off on numerous projects. Planning, public works departments and soils engineers are becoming increasingly comfortable with using the mix.

CU-Structural Soil is a result of extensive testing of different materials, ratios and trial elimination, was promulgated by Cornell University TM³ under the direction of Bassuki⁴ and Grabosky⁵ and is now patented using a specific polymer produced by AMEREQ, Inc.⁶ The make-up of structural soil is 70 to 75 percent (by dry weight) crushed stone (3/4-inch to 1-1/2-inch) and 25 to 29 percent clay loam (by dry weight). The clay loam is amended as needed to provide the required pH, organics, nitrogen, phosphorus, and potassium. Hydrogel is used to help the soil adhere to the rock during transportation and placement, reducing segregation. Thereafter, the hydrogel serves the role of hydration with the clay loam. Specifications for the mix may be obtained from the patent holder AMEREQ, Inc.

Ms. Knudson, of Lowney and Associates Geotechnical Services⁷, has provided the geotech services for

more than eight projects in California and notes that the structural soil can be placed and compacted using standard construction equipment. The as-placed material density can be measured with a nuclear density gauge, the common field test method, but she prefers that a field maximum density test be performed to compare with the field tests.

As more users install the mix, the all-important precedent of acceptance is now becoming adequately documented as a viable option. The mix is available from over sixty producers across the country. The City of Palo Alto became a field tester applying the technique in fall of 1998. Since then, the technique which started as a ripple in Cornell has now become a wave, with over 30 public and private projects applying the special soil mix in cities around the San Francisco Bay Area alone.

This number is growing every month, as designers and urban foresters are finding unique ways to adapt its use. In California, Dr. Greg McPherson is studying and will be reporting on structural soil trials being conducted by the USDA Forest Service Center for Urban Forest Research at UC Davis.

The cost, like any other project component, must be figured in to the overall project cost in advance. The larger the project, the percentage of the total costs will be less than costs applied to a smaller project. Estimate of the cubic yards for the proposed trench is relatively easy to calculate and ranges from \$30 to \$75 per cubic yard for the mix delivered — with the variable being the distance of transport. For example, the 18-mile trip from the supplier in San Jose to the project in Palo Alto was approximately \$42 cubic yard.

The new stormwater runoff requirements and BMP's for dischargers opens up another possibility of using structural soil. The structural soil matrix has superior drainage characteristics that, when integrated into the parking area design, may be considered as a detention basin, further enhancing the site capacity during peak runoff events, thereby combining capitol expenses and credits.

Summary

Using an engineered structural soil as a medium under pavement or flatwork improves tree-growing conditions and fosters longer tree life expectancy and real benefits. Incorporating structural soil into your project plans can satisfy the opposing needs of structural sub-base support for flatwork and pavement while providing a matrix for tree roots to grow laterally with access to moisture and oxygen.

As professional stewards of land, as consultants who provide technical information to our clients, and as architects and shapers of the world we will live in, we are learning how to build with the future in mind. Structural soil mix technology may not have been available to those of yesterday, but the technology is available today as a solid green building technique and an alternative tool for those who wish to change the future for the better. **LDT**

***About the author:** Dave Dockter⁸ is a Managing Arborist in the Planning Department with the City of Palo Alto, California. He is an ASCA, ISA and APA member, and has advised cities and clients on many subjects pertaining to the green industry, municipal code development, urban forestry programs⁹ and landscape architecture.*

¹ US Green Building Council, <http://www.usgbc.org>

² Personal communication with Stanford University planner, 2001

³ 1997 Cornell Research Foundation, Inc.

⁴ Nina Bassuk, Professor of Horticulture, Urban Horticulture Institute, Cornell University, nlb2@cornell.edu

⁵ Jason Grabosky, Rutgers Cook College, New Brunswick, New Jersey

⁶ 1999 AMEREQ, Inc., www.structuralsoil.com

⁷ Laura Knudsen, Lowney Associates, Government Sector Services, www.lowney.com

⁸ Dave Dockter, City of Palo Alto, 250 Hamilton Avenue, Palo Alto, CA 94301, (650) 617-3145

⁹ Palo Alto Urban Forest Programs: <http://www.city.palo-alto.ca.us/trees/>

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