Complimentary Issue

GROWINGPoints

The Design of Structural Soil Mixes for Trees in Urban Areas - Part I

There is currently a great deal of in interest in the use of compaction resistant, aggregate-based tree soil mixes. Trees need access to larger volumes of good soil than can often be reasonably provided in urban areas where other uses successfully compete for underground space. The soil under pavement in areas adjacent to tree plantings could be an important potential source of additional rooting space.

The challenge is to design soil mixes that tree roots can grow into as they mature, without causing pavement upheaval. Trees encounter several situations in the urban environment. Most commonly, the soils under areas to be paved are highly compacted to meet necessary load bearing specifications in order to reduce the potential for pavement failure due to soil settling. To accomplish this, the soils under pedestrian and vehicular pavement must be compacted to within 85% to 95% of their maximum possible density. The resulting bulk densities of these soils, as seen in Table 1, are high enough to become critically limiting to tree root growth. Tree roots are then unable to grow beyond the confines of the planting pit.

In other cases of insufficient or uneven soil compaction, or when tree roots are able to exploit the interface between the soil surface and the gravel bedding layer, tree roots escape, grow and can lift pavement in the process.

Unfortunately, trees are the primary losers in this conflict. Many municipalities install root barriers as added insurance, often severely limiting root expansion. Frequently, offending roots are simply removed, compromising both the health and stability of the tree.

The design of a structural soil mix could solve this conflict - a mix that could be compacted to legal density to ensure pavement integrity, yet still possess physical properties vital for root growth.

To better understand the concept behind structural soil mixes and how they function, it is helpful to classify soils from an engineering perspective. Professionals other than engineers typically utilize a percentage basis to describe the amount of sand, silt and clay in a soil. While this provides descriptive information on soil properties, critically needed information on the compactability of a soil can only be gained with knowledge of the subsequent distribution of grain or particle sizes in a soil. A particle size distribution curve can be generated by mechanically agitating a soil until it is

continued on page 2.....

Welcome!

To the Growing Points Newsletter. This complimentary issue inaugurates a new chapter in the long and respectable history of the newsletter. It will now originate from the Department of Environmental Horticulture of the University of California at Davis, edited by Patricia Lindsey, Landscape Horticulture Specialist.

This newsletter, broad in focus and agenda, will review new research and evaluate its applicability, and present a forum for the discussion of topical issues, all within the areas of landscape design, establishment and management. Professionals in the fields of landscape architecture and design, arboriculture, landscape contracting and horticulture will find, within these pages, information that will help them make better and more informed decisions in their area of expertise.

I will also consider for publication in this newsletter brief articles from practicing professionals on relevant topics. Likewise, if there are areas of interest readers would like to see addressed in the future, please let me know.

CONTENTS

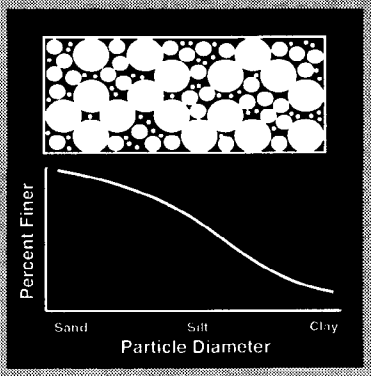

Figure 1. The particle size distribution curve (lower graph) of a well graded soil. As can be seen from the upper diagram, this soil is characterized by an even distribution of particle sizes, typical of many mineral soils.

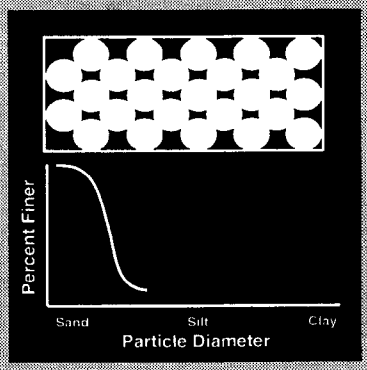

Figure 2. The particle size distribution curve for a narrowly graded soil (also referred to as a uniformly or poorly graded soil). As the diagram shows, one particle size dominates.

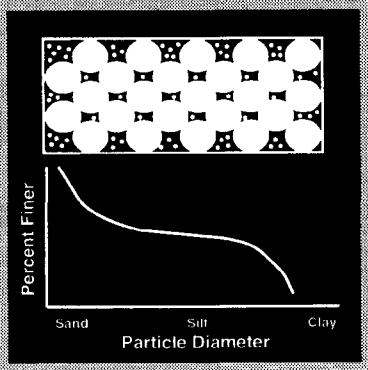

Figure 3. The particle size distribution curve for a gap (or skip) graded soil. Note that certain particle sizes are missing entirely (where the line is nearly horizontal).

Soil Mixes, cont.

sorted through a series of size graduated sieves. The percent of soil passing through each sieve is then graphed against the particle diameter size (logarithmic scale). Sieve size openings can bracket sizes from gravel and cobble all the way down to the beginning of clay size particles.

Many mineral soils are well-graded soils, with all particle sizes, from sand (0.075-2.0 mm) to silt (0.002-0.075 mm) to clay (<0.002 mm) well represented (AASHTO). Figure 1 shows the conceptual particle size distribution curve for a well-graded soil. These soils can compact readily. As can be seen from the diagram above the graph, the smaller particles in the soil can be resorted during compaction to nest within the pores spaces of the larger particles.

Bulk Density of Soils at 70-95% Relative Compaction

	Landscape	Pedestrian Paving	Vehicular Paving		
Soil Type	**70%**	**85%**	**90%**	**95%**	**Critical B.D.**
Loamy Sand (WG)	1.52	1.85	1.96	2.07	1.75
Sandy Loam (WG)	1.43	1.74	1.85	1.95	1.70
Sandy Loam (MG)	1.35	1.64	1.74	1.83	1.70
Sandy Silty Clay	1.29	1.56	1.66	1.75	1.50
Silt	1.19	1.45	1.53	1.62	1.40
Silty Clay	1.22	1.49	1.58	1.66	1.40
Clay	1.15	1.40	1.49	1.57	1.40

Table 1. The effect of specified levels of compaction on soil bulk density relative to soil texture.

Narrowly (also referred to as uniformly or poorly) graded soils tend to be dominated by a limited range of particle sizes (Figure 2). Because of this, these soils can be more resistant to compaction. Golf putting greens commonly utilize narrowly graded sand-based mixtures. This is also why a narrowly graded sandy loam soil with 70%-80% of the soil composed of sand particles greater then 0.25 mm is an excellent specification for a landscape topsoil.

The third type of particle size distribution is the one that holds the most promise for structural soil mixes for trees, a gap-graded (also called a skip-graded) soil (Figure 3). In this soil, certain particle sizes are almost completely absent. How then can we apply the concept of a gap-graded soil to a structural mix?

The engineering requirement of a structural mix may be met by creating a large particle matrix composed of aggregates used in sufficient volume or proportion so that they define the packing limitation of the soil and determine the resulting pore space. Importantly, these individual particles are all touching; the load is then transferred mainly from large particle to large particle. Skipping several particle sizes, the resulting pores between these large particles may then be filled with another, finer soil that will be relatively free from any compactive stress. It is this finer soil that will control the moisture and aeration properties of the mix and provide the media into which tree roots will grow.

Part II in the next GP issue, will address both the landscape projects where these kinds of mixes have been installed and present the preliminary results of research being conducted on a range of mixes at UC Davis.

Additional Reading:

Liu, C. and Evett, J. 1981. *Soils and Foundations.* Prentice Hall, New Jersey. 465 pp.

Al-Khafaji, A.W. and Andersland, O.B. *Geotechnical Engineering and Soil Testing.* Harcourt Brace Jovanovich College Publishers, New York. 695 pp.

Craul, P. 1992. *Urban Soil in Landscape Design.* John Wiley, New York. 396 pp.

Arnold, F. 1993. *Trees in Urban Design.* Van Nostrand Reinhold, New York. 197 pp.

The Environmental Horticulture Department and the Environmental Design Department, along with the People-Plant Council, hosted a research symposium at UC Davis in March entitled, "The Healing Dimensions of People-Plant Relations." This was the third in a series of related conferences (see the People-Plant Council sidebar). Participants came from across the U.S. and nine other counties for this conference.

During this conference, a broad array of the research currently being conducted in the area of people-plant relationships was presented. It is becoming increasingly important to document the full range of benefits to be derived from these relationships, to justify the costs of our urban forests, parks and wildlands.

The opening keynote address, "The Periodic Rediscoveries of Restorative Gardens: 1100 to the Present," was delivered by Sam Bass Warner, Meyerhoff Professor of American Environmental Studies at Brandies University.

The paper sessions covered the impact of community gardening, creating culturally diverse landscapes, examining approaches to environmental educational, an exploration of the human psyche and nature, prescriptive horticulture for the aging and disabled, the therapeutic use of plants, evaluating horticultural therapy programs, community and urban forests, and the design and evaluation of healing landscapes.

A sampling of individual papers presented included "*Landscape Preferences and Stress Responses of Ethnically Diverse Adolescents*," B. Berge and V. Lohr, Washington State University; "*Assessing the Benefits of a Therapeutic Horticulture Program in Intermediate Care*," P. Mooney, University of British Columbia; "*Horticulture Therapy and the Captive Audience: What Gardening has to Offer Inmates of Correctional Facilities*," A. McCombe-Spafford, University of Illinois; "*Practical Guidelines for Designing Gardens at Health Care Facilities*," C. Ware, ASLA, Spink Corporation; "*Therapeutic Value of the Landscape in Two Hospital Gardens in the United Kingdom*," D. Singleton, Welsh School of Architecture; "*The Effect of Therapeutic Horticulture on the Self Concept of the Mildly Intellectually Disabled Student*," D. Smith and D. Aldous, Victoria College of Agriculture and Horticulture, Australia; "*Developing Perspective: The Impact of Community Gardening on Third Party Participants*," S. Jones, ASLA, University of Oregon.

Workshops covered such topics as how to develop sustainable community landscapes, urban forestry research perspectives, and developing better research methodologies.

The symposia sessions provided one of the more stimulating and interactive forums, bringing both academicians and practitioners together in panels to address such issues as defining people-plant interactions in cultural perspective, the design, planning and evaluation of healing landscapes, and a discussion and overview of research advances in people-plant interaction.

Proceedings will be available later this spring and will include the opening and closing keynote addresses, full length papers of the research presented, and transcripts of the symposia and selected workshops. For further information regarding the content of the proceedings, call Patricia Lindsey, (916) 752-4385 or Mark Francis (916) 752-6031. To add your name to a mailing list to receive additional information on the publication date and cost of the proceedings, please contact Caru Bowns, Center for Design Research, University of California, Davis, at (916) 752-2245.

People-Plant Council

Linking Horticulture with Human Well-Being

Throughout human history plants have provided a source of healing and a window towards understanding our place in the natural world. Because of a limited ecological perspective, the scientific and technological advances and corresponding political and philosphical responses which define our current era often imperil our environment and disrupt our health, families, and communities. As the 20th century draws to a close, rediscovering and extending human understanding of our relationships to plants is essential for human and planetary survival.

The People-plant Council (PPC) was formed on May 24, 1990 as a direct result of the first national interdisciplinary symposium, "The Role of Horticulture in Human Well-Being and Social Development," held in April of 1990. The mission of this Council is to document the positive impact that plants have on human well-being and the quality of life through the psychological, sociological, economic and environmental effects they produce.

A free newsletter is available, "People-Plant Council News." This newsletter gives updates on recent research studies and the activites of related organizations, presents information on current funding sources, and each issue lists citations on different topics from the People-Plant Interaction computerized bibliographic database. Address correspondence to Dr. Diane Relf, Chair, People-Plant Council, Department of Horticulture, Virginia Tech, Blacksburg, VA. 24061-0327. Phone: 703-231-6254

TreeFinder

A Shade Tree Selection Guide

This is a computer program recently released by PG & E to aid both professionals and the homeowner in selecting trees which can meet very specific criteria. The database, three years in development with Frank Chan as Project Leader, contains over 1,150 trees.

The trees are divided into three major categories covering 1) trees for general landscape use, 2) energy conservation trees and 3) trees for use under power lines. Within each category, trees can then be sorted on the basis of adaptation to site conditions (e.g. climate, pH, exposure), function (e.g. height, form), special interest (e.g. growth rate, root damage), aesthetic (e.g. flower color, fruit color and/or maintenance. These five categories have then been subdivided until to result in a total of 40 fields or selections that can be made.

It is a very user-friendly and interactive program. It can be used both to generate plant lists for landscape projects and also serves as a powerful educational tool. The more you use it, the more you learn about different tree species.

The program is free from PG & E, at least until they have distributed the first run of copies. The hardware requirements should be noted before you inquire about receiving the program: IBM or compatible, 16-color monitor, 10 megabytes of hard disk space, 8 megabytes of RAM, MS-DOS version of 5.0 or higher, Microsoft WINDOWS version 3.1 or higher. Contact PG & E at (415) 973-6928 to receive a licensing agreement or for more information.

May Issue

- Structural Soil Mixes, Part II
- The Use of Recycled Water in Landscape Irrigation

Subscription Information

GrowingPoints is a monthly newsletter. The subscription rate is $8 for 12 issues. If your mailing label has an "EXP" beside your name, or if you are receiving this complimentary issue for this first time, please decide if you would like to renew/subscribe.

For those with current subscriptions, you should have "EXP 95 or 96" beside your name. The May issue will begin the subscription year, with all subscriptions starting from this month. Those subscribing during the yearly cycle will receive back issues.

To subscribe, mail a check to GrowingPoints, Environmental Horticulture Department, University of California, CA 95616. If you have questions concerning your subscription status, please call Susan Inman at (916) 752-0130.

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