Sidewalk and Roots: Mitigating the Conflict—*An Overview*

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The scope of the sidewalk and tree conflict is very large. In the U.S., the cost of repairing sidewalks characterized as being damaged by trees is in the hundreds of millions of dollars. In California alone, the extent of damage has been reported at $70 million by the Center for Urban Forest Research.

This article offers an overview of ways to improve the relationship and longevity of trees growing near sidewalks, streets, and driveways. Although written with the focus on the public right-of-way, the information is applicable to private property and new developments. During the discussion of sidewalks, most of the space relationships can be applicable to driveways and curb and gutter. Some applications cannot be applicable to curb and gutter because of the critical need to maintain a flow line.

Trees are valuable urban infrastructure that provides many benefits to people. Larger trees provide greater benefits than small trees. Removing and replacing a large tree with a small tree will maintain tree counts, but not maintain the same level of benefits. Therefore, whenever possible, we try to retain the existing larger trees while making a repair or create better space for larger trees in the future.

Trees need to be healthy and have a healthy growing root system. The mature size of the tree needs to be considered when a tree is planted because it will grow much larger than the nursery stock size. The size and depth of the root system also needs to be considered because most plans show the tree as a small circle that doesn't account for the root system.

Causes of the Conflict

There are many causes of damage to sidewalks besides trees. I will focus on two causes of the conflicts between trees and sidewalks:

- Trunk flare damage where the actual trunk of the tree lifts the sidewalk
- Root damage where a root emanating from the tree has caused damage to the sidewalk

The cause of trunk flare damage is a lack of space. The sidewalk is actually in contact with and lifted or offset by the enlarging tree trunk. Increasing the distance between the tree and sidewalk is the optimum way to perform the trunk flare damage sidewalk repair while retaining the tree. There are no opportunities to root-prune in this situation and put the sidewalk back in the same location. If the decision is to remove the tree, unless the site design is modified or a much smaller size-classification tree is planted, the same damage should be expected in the future.

The causes of root damage vary from shallow and surface roots in contact with the sidewalk to the radial growth increase of deeper roots causing sidewalk displacement. Sometimes the offending shallow or surface roots may be pruned. Relocating, narrowing, or modifying the sidewalk materials can reduce the need to root-prune.

New construction materials and site re-design design can provide ample space for the two infrastructure elements (tree and sidewalk) to co-exist. However, existing retrofit sites may not have the necessary space to allow for re-design that increases the distance between the tree trunk and the sidewalk. We will look at a range of options for replacing damaged sidewalks while either retaining the existing tree, or improving the design for the next tree.

Decisions, Solutions, and Innovations

In mitigating sidewalk-tree root conflicts, the decision to retain the tree will either be ***tree removal avoidance*** or ***tree preservation***. The tree removal avoidance approach focuses on the repair process and does some damage to the tree. The intent is to maintain tree stability and avoid unplanned tree failure. Tree decline or death of the tree, although not desirable, can be managed. Tree removal avoidance typically involves root pruning and soil grading—typically, cutting roots more severely than accepted standards in lieu of tree removal. The tree may often decline or shed branches in response to the root loss.

The tree preservation approach focuses on protecting the tree for maintaining the health, condition, and longevity. The intent is to avoid injury or decline to the tree, and avoid damage to the site that can cause decline or injury to the tree. An example of tree preservation is relocating the sidewalk and minimizing excavation into the root area while completing the repair. Tree preservation also includes trenching around roots and avoiding soil compaction.

The choice of sidewalk material is a major consideration in retrofitting and designing sidewalks adjacent to trees. The disadvantage of a rigid material such as concrete is that one lift point pries and raises an entire section, causing the section to be cantilevered, and offset. This can create an edge step separation greater than the actual root lift. Alternatives to concrete offer the benefits of less excavation, reduced root pruning, increased porosity, and the ability to allow roots to exist in the base material.

The disadvantage with materials that require an edge border for support is that the rigid edge can be raised and cantilevered in a fashion similar to concrete. Edge borders include the footings on tree grates and side forms on brick, interlocking pavers, decomposed granite, gravel, and rubber panels.

Re-usable materials offer the ability to repair future damage and re-using the same materials. This reduces the future materials costs during subsequent repairs or maintenance. Additionally, from a sustainability perspective, there may less material going to the landfill. Another advantage of re-usable materials is that site appearance remains more consistent over time.

Following are different sidewalk materials in common use at the time of this writing, some of their primary benefits and some of their weaknesses. All materials can be ADA compliant if designed/installed properly.

Concrete - On the plus side, this accepted standard material is solid, doesn’t need an edge treatment, and can be permeable, reinforced, tinted, textured, and shaped and formed into curves around trees. It also can be leveled by slab jacking settled areas and grinding raised edges. On the minus side, it is rigid and not reusable, is usually not permeable, and depending on soil conditions and building codes may require a 4-inch-thick compacted base beneath 4-inch-thick sections. Roots are not allowed in the base material. This often means removal of roots, impacting tree health and stability.

Asphalt - On the plus side, it is low in cost, thinner than concrete, and easily paved, shaped, and repaired. It should not need an edge form to remain in place after paving. It can be coated with a cement dust that absorbs oils and helps the surface color to be more gray reducing heat absorption. It can also be stamped and coated with color. Asphalt doesn't require a thick base when used for a walking surface. It can be placed over roots and can be permeable. The roots can remain in the base material as long as they do not contact the asphalt layer. Future repairs may only require sawcutting the failed smaller area around the root and patching with more asphalt. Additionally, asphalt can be used as a ramping or topping (skin patching) material to alleviate a raised/offset concrete area, though ramping patches don't last long in regions that experience harsh winter with freeze and thaw cycles. On the down side, Asphalt can heat up in sun and become soft, it has a shorter lifespan than concrete, it is not reusable, and its appearance is not always desirable.

Tree Grates - Tree grates provide space around the tree as long as the grate opening doesn't cut into the trunk or trunk flare as the trees grow larger in girth. The opening can be enlarged by cutting the grate material but many cities fail to keep up with this requirement. Additionally, cutting the steel can rarely be completed on site. The grates offer permeability. On the downside, the grates must sit in a concrete footing. If the grate is 4 or 5 feet square, the space between the footing and trunk and roots is inadequate, and the grate frame is the first object to be lifted. Grates and installation are one of the most expensive treatments. If larger grates are used, 6' square, or 6' X 8' or 10', the soil area between the tree and the concrete frame footing may be adequate for long term growth, although larger grates are more expensive.

Bricks over Sand – On the plus side, bricks are a common material, mid-range in cost, and have many colors. They can be placed over roots, shaped or curved, and are reusable. Bricks are considered more attractive than some treatments. There is permeability in the seams between the bricks. On the minus side, bricks require a rigid side form (wood or concrete), which can be lifted and cantilevered by roots. Bricks don't interlock, so individual bricks can be offset and not level. It is mid-range on the thickness scale.

Interlocking Pavers – On the plus side, pavers are flexible, reusable, shape-able, and decorative, typically installed on a sand base that can be placed over roots. Pavers have permeability in the seams between the pavers. A disadvantage is that they need a concrete or rigid edge band on all sides to hold them in place and this band can be lifted by tree roots. They are mid to upper level on the thickness scale. Also, interlocking pavers usually require higher maintenance to keep them looking attractive.

Decomposed Granite, aka Fine Rock Dust -This material is low cost and maintained by adding more or by re-grading. A binder can be used to help keep it together. Its border can be shaped, it can be laid over roots, and it doesn't need a deep base that can be placed over roots. On the minus side, it requires an edge band on the sides to hold it in place, and this band can be lifted by roots. Also, the surface needs more maintenance and it has the potential for dust to be tracked into homes and businesses. It can erode on slopes. The appearance may not be acceptable in some urban settings. This is mid to upper level on the thickness scale and once compacted is not very porous.

Rubber Panels - On the plus side, rubber panels are made from recycled materials and are flexible, thin (around 2 inches), and re-usable. They can be cut to shape around trees and can be placed directly over roots. The base material can be filled in around roots and graded prior to laying the rubber panels. The panels have permeability in the seams between the panels. Also, rubber panels can be manufactured to have different finish appearances. On the minus side, an edge treatment is needed and if the final grade undulates (as in rolling hills), its edges may not match perfectly. Another disadvantage is that most installations are not designed for vehicle traffic. This material is on the lower end of the thickness scale.

Plastic Panels – On the plus side, the plastic panels are made from recycled materials. They have some flexibility, thin (around 2 inches), and re-usable. They can be cut to shape around trees and can be placed directly over roots. The base material can be filled in around roots and graded prior to laying the plastic panels. The panels have permeability in the seams between the panels. Also, plastic panels can be manufactured to have different finish appearances. The panels stake directly to the ground and do not require edge treatments. On the minus side, the panels expand and need to have accurate spacing between panels. The panels don't dowel into adjacent concrete.

Poured-in-Place Rubber – On the plus side, forms for this material may be removed after the product cures and it can be poured over roots. Other advantages are that it can be shaped or curved, can be placed in thinner sections (2 inch), it doesn't need a thick base, and can the top surface can be colored for enhanced appearance. Disadvantages are that it is not reusable (no track record I am aware of), it is softer/more squishy than formed rubber panels (may be even softer in hotter climates), and its cost or contractor availability varies greatly by location. Another disadvantage is that most installations are not designed for vehicle traffic. This material is on the lower end of the thickness scale.

Polymer-Bonded Aggregate - This relatively new material consists of small aggregates of decorative stone that are glued together with a very viscous polymer which forms a bonded, porous walking surface. It doesn't need rigid side forms or a thick base. It can be shaped or curved and placed over roots. The forms are removed after the polymer cures. On the minus side, it is rigid—but repairs can be made by sawcutting and patching aggregate. As a material, it hasn't been on the market long enough for long-term evaluation. This material is on the lower end of the thickness scale, although if designed for vehicle traffic, it may be thicker.

Root Bridging - This approach creates a space between the sidewalk material and the existing tree roots while still meeting ADA standards. A slope is created using posts, piers, or arch supports; the sidewalk material is laid on the supports to leave a gap and space for the roots to grow without lifting the sidewalk. The big advantage of root bridging is that existing roots can be retained for health and stability. The bridging materials can vary, depending on height required, length of the repair area, and available budget. Common materials are wood, concrete, and composites. The main disadvantage of root bridging is that its design and construction is expensive. If the distance of the bridge is equal to a step (6 - 8 inches) above the side grade, a railing may be necessary for safety. Sometimes soil can be used to match the edge of the bridge and remove the step-off potential.

Aggregate walkways - such as *Nidagravel*, have gravel set in cells over a base material. It can be used for porous walkways and drives. Many different styles of aggregate can be used. Although the materials may be re-movable, they are on 4' X 8' cells and the sheets are overlapped making maintenance challenging. The gravel is placed about 1 inch above the cells, and they must have a raised edge (recommendation of up to 1") to hold the gravel on top of the cells in place. There is no binder, but the aggregate is supported in the cells and is supposed to be stable, only requiring minimal maintenance.

Sunnyvale's Steel Plates - An innovative method practiced for more than 15 years in Sunnyvale, California is to use steel plates to limit the future growth of the root towards the concrete improvement (see photo). Steel plates of 1/8" thickness are bolted on top of the root or placed on opposite sides of the root and bolted together, sandwiching the root. Future root growth cannot push the steel apart—rather, the root flattens between the plates. Plates are placed under or adjacent to the sidewalk to strategically limit future radial growth. This technique is more expensive than root pruning and it takes time to perform the plate work. However, Sunnyvale has not had to return to these sites for root conflicts and the trees are more stable than if they were root pruned.

Going Forward

Innovative methods of administering a sidewalk repair program are needed to achieve longer living trees and fewer conflicts. The approaches will require a good education component to receive better engineer and property owner acceptance.

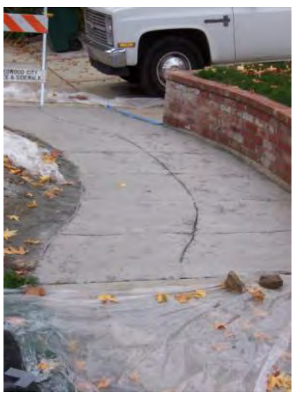
Some examples of interim and transitional approaches include:

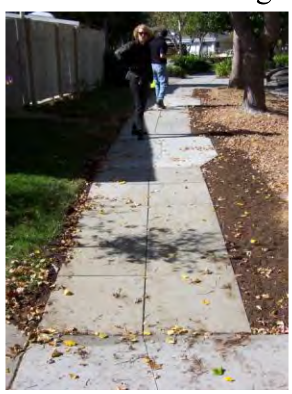
a) Planting new trees farther from the curb than the sidewalk (not just placing the tree in the center of a narrow planting strip); Trees can be planted inside the edge of the sidewalk using a half-grate or other temporary material until the sidewalk can be moved over later.
b) Relocating sidewalks farther from the tree
c) Relocating curbs farther from the tree
d) Larger tree grate systems, moving the concrete footing farther from the tree
e) Larger space around the tree/moving the concrete farther away in a downtown planting; the space can be filled with many of the materials listed above
f) Removing the sidewalk on one side of a residential neighborhood street
g) Obtaining easements to move sidewalks onto private property to provide more space for tree roots

h) Constructing more root-proof sidewalks in lieu of the traditional 4 inches of concrete over soil
i) Installing the Sunnyvale steel plate system to limit root growth
j) Designing new developments with larger planting space
k) Sidewalk Maintenance Easements on private property

If we continue to design the sidewalk-tree interfaces the same as we have in the past, we will see the same sidewalk-tree root conflicts. Fortunately, there are options for communities to consider and achieve a higher level of success in protecting their tree infrastructure assets while enjoying pedestrian walkways. As more communities strive to create walkable, sustainable, shaded neighborhoods, we need to work with community designers, civil engineers, landscape architects, planners, and elected officials to modify current practices and adopt approaches that have a higher probability of long-term success.

Photographs:


Poured in place rubber Sidewalk


Rubber Panel Installation


Roots offsetting curb and gutter; note: concrete edge band holding pavers


Roots raising sidewalk


Decomposed Granite walkway


Sunnyvale, CA steel plates over roots

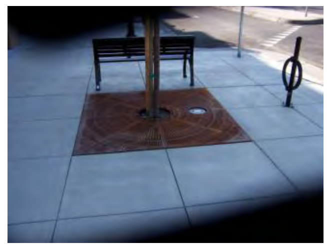
Asphalt Sidewalk

Selective root pruning,
Sunnyvale, CA

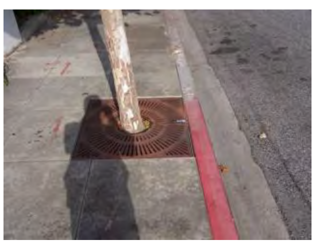
Concrete ring raised by roots
Trunk is large enough the grate was
replaced with DG

Before: Damaged sidewalk
by Monterey Pine

After: Sidewalk opened up
around tree



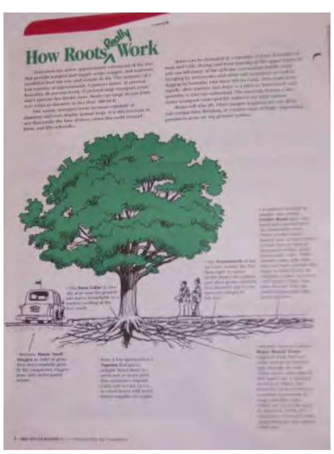
6' X 6' tree grate



2' X 3' tree grate

Tree failed in storm; was root
Pruned

Tree grates used to plant tree in best and the
location now, sidewalk will be moved next
to curb later



Arbor Day Foundation booklet
Note the root system

Large roots under sidewalk and
driveway

3 different sidewalk treatments; move away
from tree, move sidewalk next to curb, move
both sidewalk and curb away