UE 3

CONSTRUCT SUSTAINABLE SIDEWALKS

Rules of the City of New York (New York City Department of Transportation and Department of Parks and Recreation)
Proposal developed by the Site & Site Stormwater Committee

Summary

Issue:
Sidewalks have the potential to reduce runoff, mitigate the urban heat island effect, promote the use of recycled materials and increase the longevity of trees. However, city rules and regulations for sidewalks are inconsistent and are, in some cases, impediments to green sidewalks

Recommendation:
Create a single consistent sidewalk standard that includes permeable strips, water storage capacity, increased planting and recycled materials.

Proposed Legislation, Rule or Study

The Department of Transportation and Department of Parks and Recreation should revise their sidewalk rules, specifications and details to conform to the standard below. In addition, information on agency websites should be coordinated and made consistent.

Proposed Sidewalk Standard:

1. Permeable Strip. Sidewalks shall include a continuous permeable strip at the curb side. The permeable strip shall conform to the following requirements:
   i. Dimension shall be a minimum of 1/3 the sidewalk width (aka. the distance between the lot line and the curb) but not less than three feet wide along the curb side length of the sidewalk from lot line to lot line.
   ii. Tree planting Zone within permeable strip: Planting zone shall be the minimum length and depth as defined by DRP in Tree Planting Standards: Sample Tree Pit Configurations, p. 20. Planting zone shall be backfilled with topsoil per same reference standard p.9-11. Planting may include single tree, grouped trees with or without shrubs or ground covers.
   iii. Existing trees: Where existing trees are encountered in construction of a new permeable strip, the root mass shall be left undisturbed within the Critical Root Zone. Structural soil shall be placed outside of the Critical Root Zone.
   iv. Tree Planting Spacing: Trees shall be planted either individually or in groups with a minimum distance of 10 feet on center to a maximum of 25 feet. Other spacing requirements shall be as defined by DOT, DPR, FDNY and MTA with the exception that a pattern book be developed to determine tree spacing from intersections based on sight lines, traffic direction and traffic control.
   v. The Builder’s Pavement Plan shall show all existing trees on the block, indicating the species, and show the proposed new trees, indicating the species.
   vi. Requirements for non-planted permeable strips:
      a. Surface material shall be permeable based on DOT material options applicable to neighborhood classification that are in the process of development by DOT.
      b. Backfill Beyond Planting Zone within permeable strip: Between planting zones and within the full extent of the permeable strip, the backfill shall be Structural Soil as defined by DPR p. 4-7 with a depth no less than 24 inches from finished grade. The use of recycled concrete aggregate shall not be permitted due to its potential to alter the pH of the soil beyond the acceptable range for trees.
   vii. Requirements for planted permeable strips:
      a. Within this planting strip, no turf grass shall be permitted. Plants shall consist of: native meadow plantings, low herbaceous grasses or native ground covers, except that street trees within the planting strip shall have a 3 foot diameter/square mulch bed at their base.
      b. Meadow or other grasses shall be mowed once per year.

Exceptions:
1. Sidewalk zones where the distance between the curb and the lot line is less than 9’- 0” wide.
2. Areas within any sidewalk which contain sub grade structures including but not limited to subway vents or
structures, critical utility infrastructure, sidewalk vaults, and electrical vaults.
3. Areas within curb cuts.
4. Historic sidewalks constructed of brick or granite or bluestone slabs.
5. Locations where rock is present within 3 feet below sidewalk grade.

2. Sidewalk zone beyond permeable strip shall conform to the following requirements:
   i. Concrete shall consist of Type II A Portland Cement, fly ash or blast furnace slag, size no.57 stone with recycled concrete, and Type 1A Natural sand. It shall achieve a compressive strength of 3,200 PSI 28 days after the pour. For weather ability, it is to be air entrained, having an air content of 6.5% give or take 1.5%. The concrete mixture shall contain a maximum of 400 lbs. of Portland cement per cubic yard of concrete. After July 1, 2013, this maximum shall be lowered to 300 lbs. of Portland cement per cubic yard of concrete. The aggregate mixture shall contain size no. 57 stone mixed with a minimum of 10% recycled concrete, measured by weight. The recycled concrete shall be no larger than .75 inches, with no more than 1% deleterious material.

   ii. All unsatisfactory material shall be removed and replaced with suitable material. Organics such as grass and other plant material must be removed. The entire sub base must be compacted until firm. The sub grade should be wet down thoroughly and should be damp at the time of pouring.

   iii. It is required that a minimum of six (6) inches of No. 3 (1/2") stone or gravel, with a minimum of 15% recycled concrete, recycled asphalt, or glass cullet, be placed under the sidewalk. After July 1, 2013, this minimum shall be raised to 25%. The recycled concrete shall be no larger than .75 inches, with no more than 5% deleterious material, and the glass shall be a maximum of .375 inches. Recycled asphalt shall not exceed 5% of the total weight, glass cullet shall be no more than 30% of the total weight, and there is no maximum for recycled concrete. The foundation must be sufficiently compacted.

   iv. Alternatively, the foundation may be consist of a minimum of six (6) inches of Structural Soil as defined by the Department of Parks and Recreation.

       Exception: The requirements for use of recycled materials shall be waived if recycled material cannot be obtained for less than a 10% premium over the cost of virgin material.

Supporting Information

Issue - Expanded
Sidewalks in NYC make up 8% of the city - over 24 square miles in total. This means that a small change related to the design and structure of sidewalk systems will have significant environmental, micro-climate, and health impacts. New sidewalks are regularly installed, while old ones are constantly being fixed, repaired, and replaced.

The Department of Transportation is responsible for regulating sidewalks, while the Department of Parks and Recreation is responsible for regulating the trees planted in those sidewalks. Their jurisdiction overlaps on issues such as the location of street trees, size of tree pits, materials within tree pits, and extent of structural soil within tree pits. Both agencies provide specifications and details (drawings) on tree pits and these documents are not consistent with each other. In addition, the Department of Design and Construction has two sets of specifications for tree pit soil and plantings. The School Construction Authority uses details that are consistent with those of the Department of Transportation, and its own specifications for tree pits. All told, between the various city agencies and public authorities, there are at least 10 sets of inconsistent and sometimes conflicting specifications and drawings for sidewalk trees and tree pits.

This proposal would provide one standard sidewalk specification that would increase tree cover, reduce stormwater runoff, and decrease greenhouse gas emissions. It would require that the outer third of all sidewalks be permeable with at least 24" of structural soil below, referred to as "linear tree pit." As structural soil is 30% void, it can serve as a repository for storm water; almost all the rain in a 2" storm would be captured by a sidewalk designed to the proposed specification. By reducing stormwater runoff, the permeable strip will reduce flooding in sewers, subways, and roads, and reduce the pollution carried into waterways. It will also provide more root space for trees, ensuring a healthier tree canopy.

The specification also proposes that trees be planted closer together, increasing the number of trees in sidewalks. This will reduce urban heat island effect, increase natural shading and cooling through evapo-transpiration, and provide more pleasant sidewalks.

Finally, the proposal recommends that sidewalks use a concrete mixture with 50% less cement than typically used. Cement production is an energy intensive process that results in significant carbon dioxide emissions -1 ton of cement causes the release of 1 ton of CO2 emissions. Capping the amount of cement used in NYC sidewalks will reduce greenhouse gas emissions from cement manufacturing, while not decreasing performance. Using recycled material in sidewalks will also increase the amount of construction and demolition that is recycled, and reduce the amount of
environmental damage caused by quarrying.

**Environmental & Health Benefits**

This proposal will provide numerous environmental and health benefits, including reductions in greenhouse gas emissions, a decrease in stormwater, and a healthier, more widespread tree population.

This proposal was found to have a high, positive environmental impact per building and to impact a large number of buildings. It was thus given an environmental score of 3.

This proposal was found to have no significant positive health impact.

**Cost / Savings**

As described in the Executive Summary, Bovis Lend Lease prepared cost estimates for each Task Force proposal in the context of well-defined construction projects in specific buildings. Where possible, members of the Technical Committees prepared savings estimates for some of these projects and buildings. These cost and savings estimates are presented in the February 1\textsuperscript{st} draft version of Appendix A. The innate uncertainty in how construction and operation will vary from one building to another, the complexity of the Task Force proposals, and the wide range of applications in which the proposals may be realized mean these figures are truly estimates.

This proposal was estimated to increase first capital costs by 0.005%. It was thus categorized as incurring no capital cost increment.

Savings will ultimately be derived from reduced energy demand and reduced demand on sewage treatment plants.

**Precedents**

City of Los Angeles: Department of Public Works and Environmental Affairs jointly recommend investigation of technologies for permeable pavement systems and associated pilot projects, May 2008.\textsuperscript{2}

US EPA: Advocates for permeable surfaces to control selected pollutants especially Total Suspended Solids, nutrients and metals in the National Management Measures to Control Nonpoint Source Pollution from Urban Areas, November 2005.\textsuperscript{3}

FHWA: Provides diagrams and descriptions of permeable pavements, infiltration trenches and biofiltration in Stormwater Best Management Practices in Ultra urban Setting.\textsuperscript{4}


**LEED**

This recommendation may assist in achieving various LEED credits.

The following credits include options that require planting a portion of the site area with native/adapted vegetation:

- LEED NC-SS cr.5.1 Site Development, Protect or Restore Habitat; LEED EB-SS CR.4 Reduced Site Disturbance, Protect or Restore Open Space; LEED for Schools-SS cr. 5.2 Site Development, Protect or Restore Habitat; and LEED ND (pilot program)-GCT cr.7 Minimize Site Disturbance during Construction.

Utilizing recycled concrete will assist in obtaining the following credits:

- LEED NC- MR cr.4.1 & 4.2 Recycled Content; LEED CI-MR cr. 4.1 & 4.2 Recycled content; LEED EB-MR cr.2 Optimize use of Alternative Materials; LEED for Schools MR cr.4.1 & 4.2 Recycled Content; LEED for Homes MR cr. 2 Environmentally Preferable Products; and credits under the various pilot programs. Additionally, for concrete recycled on site, LEED MR credits relating to Construction Waste Management are available for diverting waste from disposal.

Various LEED credits refer to detention facilities to mitigate stormwater runoff. These LEED credits include:

- NC SS 6.1 Stormwater Design: Quantity Control Option 1B; LEED for Schools SS cr.6.1 Stormwater Design: Quantity Control; LEED ND-GCT cr.9 Stormwater Management; LEED CI-SS cr.1B Site Selection; and LEED for Homes SS cr. 4 Surface Water Management; and LEED EB-SS cr. 5 Stormwater Management.

The following LEED credits address mitigation of the heat-island effect through the use of permeable site surfaces:

- LEED NC-SS cr. 7.1 Heat Island Effect, non-roof; LEED CI-SS cr.1D Heat Island Effect, non-roof; LEED EB-SS cr.6 Heat Island Reduction; LEED for Schools SS cr.7.1 Heat Island Effect, non-roof; LEED for Homes SS cr.4.1 Surface Water Management; LEED ND-GCT cr.10 Heat Island Reduction (pilot program).
Implementation and Market Availability

There are no known implementation issues for this proposal. Multiple local suppliers carry structural soil and there are many manufacturers of permeable pavements.

Notes

Mitigation Strategy for Locations Exhibiting Poorly Draining Soils

Proper tree planting methods recommend a percolation test in every proposed tree pit. In the condition of continuous tree trenches, percolation tests should be conducted every 50 feet if poorly drained soils are suspected. Poorly drained soils are those that percolate at less than 1 inch per hour. There are multiple mitigating measures that can be employed in this instance. One is the use of a vertical sump drain in which an approximately 8 inch diameter auger drills through the poorly draining soil until it reaches better draining soil. This column is then filled with sand to allow water to move from the poorly draining tree trench into free draining soil below. Another technique is to use underdrainage, or perforated plastic pipe wrapped in filter fabric. This method would use a continuous 4 to 6 inch diameter perforated plastic (HDPE) pipe wrapped in filter fabric with a connection to an outlet pipe or sewer line. A third option is to continuously slope the tree trench to a sump or to an area of better drained soils. A fourth option is to use tree species that are more adapted to periodically saturated soil conditions.

Evapotranspiration

One of the major benefits of more sidewalk trees is their ability to return moisture (rainfall) back into the atmosphere. A 6-8 inch caliper tree with a crown diameter of 20 feet can extract 6.21 inches of water in a 31 day period in July, or 0.2 inches per day, or 4.19 cubic feet of water per day or 30 gallons per day [Trees in the Urban Landscape, p. 80]. Evapotranspiration is a major mitigating factor in reducing concerns of soil saturation.

Rainfall Interception by Trees

The leaves, branches and trunks of trees intercept rainfall. Tests demonstrate that a 9 year old tree, 28 feet tall with a 19 foot canopy spread can intercept 68% [58 gallons per square foot] of a 0.5 inch storm event [86 gallons per square foot]. [http://www.fs.fed.us/psw/programs/cufr]

Soil Volume Calculations

Current Department of Transportation (DOT) standards recommend that trees be planted in a tree pit of 5 feet by 5 feet by 3 feet depth. This is equivalent to a soil volume of 75 cubic feet. The Department of Parks and Recreation (DPR) recommends tree pits be as large as the sidewalk space permits, recognizing limitations of obstructions and required clearances. The current DPR/DOT recommended spacing of trees is 25’- 40’. Since there is no current provision for continuous trenches between trees, the tree root’s ability to extend beyond the tree pit is highly compromised due to our heavily compacted and unsuitable urban soils. The calculation of appropriate soil volume is based on many criteria including the soil quality, water holding capacity, tree canopy at maturity, availability of adjacent soil into which tree roots can expand, microclimate and the like. Research has demonstrated that shade trees in NYC’s climate will attain greater height and canopy spread, survive longer, and sustain drought better with more soil volume. This proposal provides the following:

<table>
<thead>
<tr>
<th>Tree Trench Width/Depth</th>
<th>On center Tree Spacing</th>
<th>Soil Volume per Tree</th>
</tr>
</thead>
<tbody>
<tr>
<td>4 feet x 24 inches</td>
<td>10’ – 15’</td>
<td>80 – 120 cubic feet</td>
</tr>
<tr>
<td>4 feet x 24 inches</td>
<td>20’ – 25’</td>
<td>160 – 200 cubic feet</td>
</tr>
<tr>
<td>5 feet x 24 inches</td>
<td>10’ – 15’</td>
<td>100 – 150 cubic feet</td>
</tr>
<tr>
<td>5 feet x 24 inches</td>
<td>20’ – 25’</td>
<td>200 – 250 cubic feet</td>
</tr>
<tr>
<td>6 feet x 24 inches</td>
<td>10’ – 15’</td>
<td>120 – 180 cubic feet</td>
</tr>
<tr>
<td>6 feet x 24 inches</td>
<td>20’ – 25’</td>
<td>240 – 300 cubic feet</td>
</tr>
</tbody>
</table>
The basic proposal is for a 24 inch deep continuous tree trench backfilled with structural soil beyond the immediate root ball zone. Trees planted initially at larger calipers (greater than 5 inches) will need deeper tree pits, however the trench beyond the root ball can remain 24 inches and retain effectiveness. This is due to the fact that the overwhelming majority of tree roots, particularly the feeder roots, are located within the top 6 to 24 inches of the soil. Roots only grow where the physical and chemical environment is correct in terms of temperature, moisture, aeration, pH, nutrient supply and soil moisture. Furthermore, a continuous trench between trees allows for shared root space so the actual available volume is greater. To date there is no conclusive research that allows a determination as to how much less soil volume can be specified if soil volumes are contiguous, but research shows that tree roots in natural settings extend 2 to 4 times the diameter of the crown.

Stormwater Catchment Area of Sidewalk Tree Trench

The stormwater catchment area used in the calculations in this proposal assumes a continuous and even cross slope on a sidewalk from the building face to the edge of the trench plus the water falling directly on the trench. Therefore, on a 15 foot wide sidewalk, there would be a 5 foot wide permeable tree trench and a 10 foot wide zone of impervious surface draining into the trench. This assumes in a typical 100 foot long trench a catchment area of 1000 SF of impermeable surface and 500 SF of permeable surface contributing water to the trench.

ENDNOTES:


2 CITY OF LOS ANGELES, INTER-DEPARTMENTAL CORRESPONDENCE (May 21, 2008) available at eng.lacity.org/.../2008%2F200805%2F20080521/.../20080521_ag_br_st_san_ce_1_tr1.pdf
