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A Buyer's Technical Guide to Root Barriers

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Various commercially available root barriers with internal vertical ribs are compared on a performance basis to augment their descriptions by manufacturers.

The frequently described conflict between tree roots and sidewalks remains one of the most pervasive problems confronting urban forest managers (2,3). Research indicates that root barriers can substantially reduce root biomass in the top foot of soil within a 3-foot radius from the tree trunk (Barker, unpublished data). Whether such results translate into less conflict between tree roots and sidewalks over time is still in question. Current manufacturers continue to design and produce new barriers and additional companies are entering the marketplace for the first time. As competition and barrier variety increase, consumers need unbiased sources of information to determine whether or not to use barriers and, if they are to be used, which barrier will best suit particular site requirements.

Numerous kinds of root barriers are commercially available for an urban tree manager who considers root barriers worth using. An early root barrier, introduced in 1976, is marketed as the Standard Deep Root Planter™ (Patent No. 4019279). Made of thick plastic, this sturdy barrier is 18 inches deep and 22 and 29 inches square at the top and bottom, respectively. Other barriers now being marketed are designed for ease of packaging and shipping. These are either flat panels for connecting together at point of use to make whatever length is desired or they are continuous barriers that are rolled up for shipping and may or may not be pre-cut to a specified length. Either type of barrier may be installed linearly along sidewalks or cylindrically as planting hole liners.

Of the numerous root barriers available, most of them have internal vertical ribs intended to direct roots downward and thus retard development of circling roots. This paper discusses characteristics of four panel type and two continuous barriers, each with internal vertical ribs. The paper is based on our observations during and following installation in May 1993 of the panel type barriers in a field experiment at the Solano Urban Forestry Research Area (SUFRA) in northern California and on our observations of the continuous barriers in actual use. Each of these barriers is briefly described, alphabetically by manufacturer, in Table 1.

Important in selecting a barrier is the material it is made of and various design features, notably the way in which either the panels or the ends of continuous barriers are connected together. Panels may be joined together with interlocking couplings, separate

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Table 1. Manufacturers, materials, prices, and design features of five ribbed root barriers, listed alphabetically by manufacturer

Manufacturer	Material	Panel depth in.[1]	Quoted retail price per linear foot	Rib length	Rib height in.	Rib type and angle degrees	Watering tubes attached to barrier	Panel connecting device[2]	Other features
Bumble Bee Products, Inc., 3260 Industry Dr., Signal Hill, CA 90806 310-597-7933	Polyethylene, high-density, injection-molded	12 24	$1.70 3.25	Entire depth of panel	9/16 9/16	90 90	No No	Separate extruded connector	Notched at bottom for tearing by maturing roots
Century Products 1401 N. Kraemer Blvd. #B Anaheim, CA 92806 714-632-7083	Polystyrene, extruded, w/ultra-violet stabilizer	18 x 69 18 x 120 24 x 69 24 x 120	2.74 2.56 3.44 3.06	Entire depth of panel	5/8 5/8 5/8 5/8	45[3] 45[3] 45[3] 45[3]	Yes Yes Yes Yes	Connector glued w chloromethane solvent	
Deep Root Partners, L.P. 345 Lorton Ave. # 305 Burlingame, CA 94010 800-458-7668	Polypropylene, injection-molded	12 18 24	2.18 3.28 4.10	Ends 1/4" from panel bottom	1/2 1/2 1/2	90 90 90	No No No	Separate extruded connector	Antilift pads to keep panels from lifting once installed
Shawtown Industries, Inc. 4550 Calle Alto, Unit D Camarillo, CA 93010 800-772-7668	Polystyrene, extruded	12 18 24 48[4]	2.25 3.50 4.60	Ends 1/4" from top and bottom	1/2 1/2 1/2 1/2	90 90 90 90	No No No	Inter-locking coupling	Tight fit of locking device deters panel slippage
Vespro, Inc.[5] 40 Belvedere St., Unit 2 San Raphael, CA 94901 415/459-7311	Polyethylene, low density, extruded	12 18 24		Entire depth of panel	Varies 1/4 to 3/4	"agonic curl," 90° arc	No No No	Inter-locking coupling	

[1] All panels 24 inches wide unless otherwise noted.
[2] Illustrated in Figure 1.
[3] Hollow triangular tubes molded to inside wall of barrier.
[4] Special order.
[5] Retooling to produce a different design.

connectors or locking strips, or by use of chemical bonding agents (Fig. 1). As indicated in Table 1, the panels may be made of polyethylene, polypropylene, or polystyrene. Among these three thermoplastics, polyethylene in the high density formulation is recognized in the plastics industry as most resilient and durable. By comparison, polypropylene is slightly harder and therefore eventually may chip or crack easier. Polystyrene, on the other hand, crystallizes readily in the presence of sunlight, in which case its durability is compromised.

Panel Barriers

We installed 46 each of the panel-type Bumble Bee, Deep Root, and Vespro barriers in two field studies at SUFRA in May 1993. Each barrier, installed as a planting hole liner, consisted of three panels connected with either separate locking strips or interlocking couplings. Two-year-old, bare root seedling trees, each approximately 6 feet tall, were planted by backfilling with unamended native soil inside the barriers after which gaps between the exterior of the barriers and the planting holes were collapsed with a shovel. When a tree was planted, the top edge of each barrier extended above grade at least 1 inch. Three months after installation, eight barriers if each kind were randomly selected and examined.

Characteristics unique to each barrier are discussed below in alphabetical order.

Bumble Bee Barrier (Patent No. 4995191)

A circular shape of this high-density polyethylene barrier was easily maintained while the trees were being planted. Of particular importance, neither the panels nor the connectors were predisposed to slipping out of alignment while the soil was being backfilled.

The 8 randomly selected trees for follow-up examination exhibited no signs of chipping or breakage of the rim above grade level. Uneven settling of panels was not apparent; however, we did observe chipping and tearing—probably due to impacts by mower wheels—of a few of the internal vertical ribs that protruded above grade level. Ribs are designed to redirect root growth downward, and any that are broken provide an opportunity for roots to grow in a circular pattern until they meet an intact rib.

In a 3-year old installation of these barriers at the University of California in Davis, some of the panel connectors had already cracked or ruptured above grade. We understand the manufacturer now makes these connectors with a more durable polystyrene.

Deep Root Barrier

A circular shape of this polypropylene barrier was easily maintained while a tree was being planted. On the other hand, because of looseness of fit of the installed locking strips, they had to be held in place and often repositioned to line up with the top edge of the panels during soil backfilling.

Three months later, one of the eight randomly selected Deep Root barriers exhibited settling of individual panels, leaving top rims only half an inch above grade level. "Anti-lift pads," which are small tabs running horizontally around the inside of these barriers to stabilize the panels and keep them from lifting once installed, may actually have a reverse effect. Gravity, along with weight of the water-saturated soil inside the barriers may be causing them to settle. Also, the top edge or rim on one of the barriers had a 4-inch long tear at ground level, obviously resulting from a mower wheel hitting it.

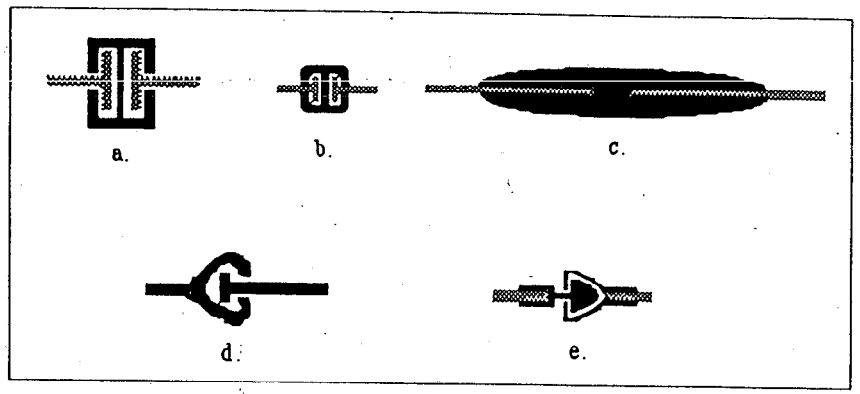

Figure 1 — A schematic of cross sections of root barrier panel connectors. Deep Root (a) and Bumble Bee (b) barriers use separate locking strips that slide over panel ends. Century (c) uses chloromethane solvent to bond connector to panels. Vespro (d) and Shawtown (e) have interlocking coupling connectors that are either extruded with the panel or bonded to the panels during manufacturing. Approximate scale.

Deep Root barriers installed approximately 3 years ago at Dan Foley Park in Vallejo, California, reveal minor chipping and cracking above grade level.

Shawtown Barrier

We have recently installed samples of this barrier at SUFRA to observe the long term effects of environmental exposure, particularly sunlight, on barriers made of polystyrene. During installation, the circular shape of the barriers was easily maintained. The interlocking coupling on the barrier is bonded to the panels at the factory and we saw no evidence of panel slippage after we assembled them.

Vespro Barrier

This barrier, among the three types of barriers used in the previously mentioned field studies at SUFRA, was most cumbersome to handle. Because it was made of low-density polyethylene, it was extremely malleable, becoming more so as temperatures increased. During installation, therefore, one person had to continuously hold it in a circular shape while another person backfilled the soil within the barrier. Even with this extra help, the installed barrier had an uneven undulating shape, which complicated the mowing and edging of turfgrass surrounding the barrier.

The connecting device of this barrier is an interlocking coupling, which is extruded as part of each panel. Despite the simplicity of this coupling and, therefore, ease of connecting the panels, separation of the panels after barrier installation posed a problem. Panels separated once when we inserted one of two tree stakes in the backfill soil inside the barrier after the tree had been planted. This required panel replacement and replanting of the tree. A close examination of the coupling revealed that it was uneven because of faulty extrusion. It was also possible to separate connected panels by pulling them apart by hand. In short, the pliancy of this barrier compromises its structural integrity.

Two of the eight Vespro barriers examined 3 months after installation had vertical tears in the 1-inch, above-grade segment, at the mold joints of the internal ribs. Individ-

ual panels on four of the barriers had settled unevenly, but still remained above grade level. There was no evidence of further separating of panel connectors; however, undulation of the cylindrical shape of the barriers had become more pronounced.

Continuous Barriers

We installed samples of continuous barriers marketed by Century and Shawtown at SUFRA in June 1993 to observe long-term effects of environmental exposure. Both barriers maintained their shape as trees were being planted.

Century Barrier

Assembly of these barriers as they were being installed required use of chloromethane solvent (methylene chloride) to bond the locking mechanism to the panels. Although easy to use, chloromethane may pose health hazards to installers. Failure to glue the connector to the barrier ends could allow separation of the barrier ends when or shortly after a tree is planted and growth of tree roots through the gap. There is no experimental evidence that the hollow triangular tubes glued onto the inside wall of this barrier will prevent circling roots, as intended. Nor is there experimental evidence that soil aeration and water application is effectively enhanced with these tubes or with larger watering tubes that are sometimes glued onto the outside wall of this barrier.

Shawtown Barrier

Observations of Shawtown continuous barriers installed in 1992 along a sidewalk in Fresno, California, revealed extensive breakage from rim tops to ground level. This was no surprise because elsewhere we have seen polystyrene barriers begin breaking and crumbling within 1 to 2 years, due to its tendency to crystallize and become brittle when exposed to sunlight.

Materials Testing

Pamphlets distributed by the manufacturers to advertise barriers provide information on the tensile, flexural, and impact resistance properties of their products (Table 2). This

Table 2. Alphabetical listing of results of engineering tests reported in barrier manufacturers' brochures.

Barrier	Material thickness, mil (1/1000 in.)	Tensil strength, (ASTM D 638), psi	Flexural properties (ASTM D 790)		Impact resistance (ASTM D 256)	
			Strength, psi	Elasticity, psi	Izod., ft.-lb.	Gardner/ Rockwell, in.-lb
Bumble Bee	80	2000	30,000	N/A[1]	N/A	N/A
Century	60	3800	6,500	3.0	2.0	70 (G)
Deep Root	80	3800	155,000	N/A	7.1	68 (R)
Shawtown	80	7400	13,200	400,000	8.5	102 (R)
Vespro[2]	70	2000	30,000	N/A	N/A	N/A

[1] Datum not available.
[2] Currently retooling to produce a different style barrier.

information is based on the results of plastics engineering tests run in accordance with American Society for Testing and Materials (ASTM) guidelines (1). But what do these test data reveal to consumers? The ASTM guidelines repeatedly state that results of stress and flexural tests conducted on plastics under laboratory test conditions do not indicate that the same relationships will exist under temperatures and other environmental parameters widely different from those of the test conditions. This is because of the high degree of sensitivity of many plastics to rate of straining under different environmental conditions. Nor are impact test results generally considered a measure of the abrasion or wear resistance of these plastic materials.

Overall, the significance and use of these tests is for quality control and specifications purposes during production (1). Data derived from these tests and reported by barrier manufacturers in their advertising brochures and product labels do not provide consumers with information on how the barriers will resist the wear and tear of daily exposure to foot-traffic, landscaping equipment or other performance features. Until better information is available, on-site observations of barrier performance, as reported in Table 3, will be critical in sorting out which barriers best meet particular purposes.

A barrier's effectiveness is nullified if the top edge is not permanently visible. Roots have readily overgrown barriers in experiments at SUFRA that were accidentally covered with even thin layers of soil (Barker, unpublished data). We see this same problem in commercially installed landscaping anytime soil or organic mulch of any depth obscures the top edges of root barriers (Fig. 2). Similarly, it is vital that barrier panels not pull apart or crack because of faulty connectors. It may be no coincidence that the two barriers made of either high-density polyethylene or polypropylene and exhibiting superior sturdiness and durability were injection molded. Predisposition of all of the barriers to above-grade damage by foot-traffic and landscaping equipment may be markedly altered by designing a wider, more durable top edge on the barriers, a feature that would require that they be made by injection molding instead of by extrusion. Manufacturers are aware of the above-grade wear and tear problem, and some are aggressively addressing it. Deep Root has recently started marketing a new barrier with a sturdy 7/16-inch wide top edge designed to support foot traffic and retard root overgrowth. Controlled longevity of

Figure 2--Tree roots overgrowing a root barrier where the top edge had been covered by a thin layer of organic mulch. (Note: photo replaces an incorrect one in the publication).

Table 3. Comparison of five root barriers based on observations during and after their installation, listed alphabetically by manufacturer

Barrier manufacturer	Installation instruction	Maintains shape while being installed	Panel slippage or settling during or after installation	Connector slippage, settling, or failure	Possible problem[1]
Bumble Bee	In sales brochure only	Yes	No	No	
Century	In sales brochure only, no instructions for use of bonding agent	Yes	No	No	Health risk of inhaling chloromethane bonding agent, comparatively short life expectancy of polystyrene material exposed to sunlight
Deep Root	Printed on shipping carton and on inside of each panel	Yes	Yes	Must be adjusted during installation	
Shawtown	Printed on shipping carton and on inside of each panel	Yes	No	No	Comparatively short life expectancy of polystyrene material exposed to sunlight
Vespro[2]	In sales brochure only	No	Yes	Pulled apart, once installed	Highly malleable, easily loses circular shape; connector failure and above-ground portion of panels occasionally rip vertically

[1] Besides possible breakage of above-ground portion of barrier by foot traffic, mower wheels, or other impacts.
[2] Currently retooling to produce a different style barrier.

root barriers is still another attribute needing attention (4).

In summary, though there still is no clear evidence that the use of root barriers on street trees does not harm the trees and does, indeed, reduce sidewalk damage, root barriers currently on the market, including those herein described, are providing urban tree managers; landscape architects, and home owners with options for dealing with tree roots that grow differently than desired. Moreover, root barriers still are being improved, driven by experiences of consumers and manufacturers and by rigorous experimentation.

Acknowledgment

Use of trade or firm names in this paper is for reader information and does not imply endorsement by the U.S. Department of Agriculture of any product or service.

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