



United States Department of Agriculture  
Forest Service



U.S. Department  
of Transportation  
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Administration

# Tech Tips

National Technology & Development Program • **Recreation** • February 2013 • 2300 • 1223-2310P-MTDC

## Innovative Foundations for Boardwalks and Viewing Platforms

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Several methods are used for constructing elevated boardwalk foundations across areas with standing water. Digging holes or driving piles into swampy ground and building up stone and log cribbing are two conventional techniques. The tech report “Wetland Trail Design and Construction, 2007 Edition” (0723-2804P-MTDC), <<http://www.fs.fed.us/eng/pubs/htmlpubs/htm07232804/index.htm>> provides information on traditional techniques for constructing elevated boardwalk foundations.

This tech tip focuses on two less commonly used techniques:

- Helical piles to support the superstructure
- Prefabricated concrete foundations, such as curbs placed on a bed of geocells filled with gravel and wrapped in geotextile fabric

### Highlights...

- Digging holes or driving piles into swampy ground and building up stone and log cribbing are conventional techniques for constructing elevated boardwalk foundations.
- Driving helical piles to support the boardwalk superstructure and placing prefabricated concrete foundations are less common but useful techniques.
- Helical piles cause minimal ground disturbance. Prefabricated concrete foundations resist movement during floods and are well suited for areas with rocky or thin soils.

The U.S. Department of Agriculture, Forest Service, Trails Unlimited enterprise team used these foundations on three projects. Trails Unlimited designed and/or installed:

- Helical piles for a viewing/fishing platform as part of an accessible trail on the U.S. Department of the Interior, U.S. Fish and Wildlife Service, Okefenokee National Wildlife Refuge in Georgia (figure 1)
- Helical piles to support an elevated boardwalk on the Town Creek Off-Highway Vehicle (OHV) Trail system at the Chattahoochee-Oconee National Forest in Georgia (figure 2)
- Precast concrete with 3-inch steel pipe posts to support a stout, high-elevation boardwalk (250-pounds-per-square-foot snow load) over a seasonally wet meadow (figure 3) on the Snake Creek Trail at the Inyo National Forest in California



Figure 1—Helical piles support this viewing/fishing platform at the Okefenokee National Wildlife Refuge in Georgia.





Figure 2—This elevated boardwalk on the Town Creek Off-Highway Vehicle (OHV) Trail system at the Chattahoochee-Oconee National Forest in Georgia is supported by helical piles.



Figure 3—Precast concrete barriers on top of geogrid filled with stone provide solid footing for this Snake Creek Trail boardwalk at the Inyo National Forest in California.

## Helical Anchors and Piles

A helical anchor, pile (figure 4), or pier is a foundation system consisting of round or square steel shafts with one or more helical bearing plates welded to it. These versatile earth anchors are used in highway retaining walls; for supporting building foundations, power lines, and streetlight bases; and for supporting elevated boardwalks. Pile installation depth is limited by soil density and economic practicality. Additional lengths are bolted on as depth increases.

Several companies manufacture helical piles. A helix (one pitch of a screw thread) provides the bearing surface. Choosing the correct size and quantity of helical piles for a specific project involves calculations based on the supported load, soil structure, and soil density. These calculations often are determined by a certified installer or under the guidance of a geotechnical or structural engineer.



Figure 4—Specialized equipment is needed to install helical piles. For this installation, Trails Unlimited installed 12 helical piles for 4 viewing platforms in 4 hours.

## Advantages and Disadvantages

Helical piles have some advantages and disadvantages when compared with conventional techniques.

### Advantages

- Helical piles cause minimal ground disturbance in wet and sensitive soil environments.
- Helical piles are cost effective in wet/swamp/marsh environments with soft or clay soils.
- Galvanized helical piles resist corrosion, unlike wood piles that may rot.
- Helical piles do not leach wood preservative into the surrounding environment.
- Helical piles can be installed rapidly when proper equipment is used.

### Disadvantages

- Helical piles require professional sizing and soil measurement expertise.
- Installation often must be contracted, or at least requires special screw heads and hydraulics for the mini-excavator or other power source.
- Helical piles may require ingenuity for “install-as-you-go” build sequencing when installing piles in deep standing water.
- Helical piles are not a good option for rocky soils or where bedrock is close to the surface.

## Installation Sequence for the Viewing/Fishing Platform

The following steps illustrate the installation process.



Step 1—Helical piles are measured and installed for this 8-foot by 16-foot viewing/fishing platform. Typical depth after installation (depending on soil resistance) is 7 to 18 feet. Additional bolt-on shaft extensions come in 3-, 5-, and 7-foot lengths.



Step 2—The torque applied to install the helical piles is closely monitored and converted through calibration to pounds-per-square-foot load that determines the installation depth.



Step 3—Helical piles can be installed vertically or at an angle. Angled installations are especially useful when cross-bracing for lateral support.



Step 5—The structure is cantilevered 2 feet over the helical piles to allow water to drain off the boardwalk while avoiding the exterior beams. This also allows better access for fishing.



Step 4—Saddle brackets are bolted to helical piles to support the header beam, forming a bent. In this case, the timbers are alkaline copper quaternary (ACQ)-treated southern yellow pine.



Step 6—Simpson Strong-Tie metal components are used to tie down the joists to the header beam.



Step 7—The nonelevated end of the structure is secured to a partially embedded plastic curb sill.



Step 9—The front handrail is sloped to allow the legs and front wheels of a wheelchair to be positioned slightly underneath the top rail. The handrail height is 34 inches. Welded wire mesh is installed to discourage alligators from using the platform, to provide better views of the canal channel scenery, and to prevent small children from falling in the water.



Step 8—The viewing/fishing platform support system.

### Installation Sequence for the Off-Highway Vehicle (OHV) Elevated Boardwalk

The following steps illustrate the installation process.



Step 1—The OHV elevated boardwalk is installed during a dry period while accessibility for equipment is good. The first step requires removing the existing deteriorated boardwalk.



Step 2—Helical piles are installed using a mini-excavator with a special screw head and hydraulics. The contractor installed 90 helical piles at an average depth of 10 feet over 3 long workdays. Helical piles are installed both vertically and at an angle. The direction of the angled piles alternates between bents for lateral bracing purposes.



Step 4—Galvanized steel saddle brackets attach to the helical piles and header beams to form a bent.



Step 3—Galvanized steel brackets are used for lateral bracing.



Step 5—Header beams fastened to vertical and diagonal helical piles provide both support and lateral stability.



Step 6—Stringers are set in place and attached to the header beams.



Step 8—Bracing is added between the stringers to prevent the stringers from rotating.



Step 7—Stringers are carefully placed on header beams and Simpson Strong-Tie metal components are used to join members.



Step 9—Curbing (6 inch by 6 inch or 4 inch by 4 inch, depending on the width of maintenance equipment using the boardwalk) on top of scupper blocks is specified in lieu of railings for this OHV trail.



Step 10—Backwall planks installed at the end of the boardwalk keep dirt from sloughing between the beams and prevent moisture from wicking into the ends of the beams.



Step 11—Masonry block pavers at the boardwalk approaches provide a firm transition from the trail to the boardwalk and minimize soil settlement.



Step 12—A closer view of the Perstone pavers used in the installation.

## Precast Concrete Foundations

Heavy precast concrete foundations resting on a 6-inch layer of gravel-filled geocell wrapped with geotextile fabric anchor the stout, high-elevation boardwalk on the Snake Creek Trail at the Inyo National Forest in California. An additional 6,000 pounds of uplift force resistance is provided by two Manta Ray earth anchors attached through each concrete foundation. This area is subject to heavy seasonal flooding. The concrete sills resist uplift during the spring runoff. The geocell base helps spread the load of the structure, eliminating the loading differential that might occur with single posts. The boardwalk is designed to handle snow loads of 250 pounds per square foot, which is considerably greater than the American Association of State Highway and Transportation Officials (AASHTO)-required pedestrian live load of 90 pounds per square foot.

## Advantages and Disadvantages

Precast concrete foundations have some advantages and disadvantages when compared with conventional techniques.

### Advantages

- Heavy concrete resists movement during floods.
- Geocell provides a broad base to spread loads.
- Precast concrete foundations do not leach wood preservative into the surrounding environment.
- Precast concrete foundations are well suited for areas with rocky or thin soils where helical piles or wood posts would be unable to penetrate the ground.
- Precast concrete foundations provide better quality control and faster field construction.

### Disadvantages

- Precast concrete foundations are heavy and impractical in remote areas without nearby road access.
- Machinery is required to move the concrete foundation and preassembled substructure into place.



## Installation Sequence for the Stout, High-Elevation Boardwalk

The following steps illustrate the installation process.



Step 1—A trench 8 feet by 3 feet by 1 to 2 feet (depth depends on the required substructure ground elevation) is excavated to accommodate the wrapped geocell and precast concrete foundation.



Step 2—Geosynthetic fabric is placed, and the geocell is staked and filled with gravel. Geosynthetic fabric is folded over the top.



Step 3—The substructure consists of a 6-foot by 18-inch by 12-inch precast concrete foundation. The top of the concrete foundation is 9 inches wide and has a 6-inch by 6-foot by  $\frac{3}{8}$ -inch flat steel plate with 7-inch shear studs cast into it. The posts (3-inch diameter galvanized steel pipe with  $\frac{1}{4}$ -inch walls) are welded to the steel plate. Rebar hooks embedded in the curb allow the curb to be moved by machine.



Step 4—The substructure is placed on top of the wrapped geocell filled with gravel so it is flush with the final ground elevation. Two Manta Ray earth anchors are installed for each precast concrete foundation to restrict uplift and lateral movement.



Step 5—The trench is backfilled with suitable excavated material.



Step 8—Two-inch-wide galvanized steel C-channel cross-bracing is added where the structure is 3 feet or higher above the ground.



Step 6—Saddle brackets are bolted to the tops of the pipes and 1/8-inch weep holes are drilled at the bottoms to prevent water from collecting, freezing, and breaking the pipes.



Step 9—Steel angles bolted to the stringers hold them in place.



Step 7—Pipe sleeves are used to bolt saddle brackets to the pipes and header beams to form a bent.



Step 10—Where steel pipes are not needed, a 1/4-inch thick neoprene pad is placed between the foundation block and beams to keep moisture away from the wood beams.



Step 11—The finished structure features curbs with scupper blocks for this all-terrain vehicle/motorcycle trail.

## Summary

New and innovative alternatives to traditional substructures are available when determining the foundation design for boardwalks or viewing platforms. These alternatives can help minimize ground disturbance, be more cost effective, and provide greater life expectancy in wet and sensitive environments.

## References

Steinholz, Robert T.; Vachowski, Brian. 2007. Wetland trail design and construction, 2007 edition. 0723–2804P–MTDC. Missoula, MT: U.S. Department of Agriculture, Forest Service, Missoula Technology and Development Center. 90 p. Available at <<http://www.fs.fed.us/eng/pubs/htmlpubs/htm07232804/index.htm>>.

## About the Authors

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**James Scott Groenier** began working for MTDC in 2003 as a civil engineer. Groenier earned a bachelor's degree from the University of Wisconsin at Madison and a master's degree from Montana State University. He worked for the Wisconsin and Illinois State Departments of Transportation before starting his career with the Forest Service. He worked as the east zone structural engineer for the Eastern Region and as a civil engineer for the Ashley and Tongass National Forests.



## Library Card

Barrow, Jerry D.; Groenier, James Scott. 2012. Innovative foundations for boardwalks and viewing platforms. Tech Tip 1223–2310P–MTDC. Missoula, MT: U.S. Department of Agriculture, Forest Service, Missoula Technology and Development Center. 12 p.

Helical piles and prefabricated concrete foundations are two innovative methods used for constructing elevated boardwalk and viewing platform foundations across areas with standing water. The U.S. Department of Agriculture, Forest Service, Trails Unlimited enterprise team used these methods on three projects. This tech tip provides step-by-step descriptions of these installations and explains some advantages and disadvantages of using helical piles or prefabricated concrete foundations.

**Keywords:** boardwalks, elevated boardwalks, foundations, helical piles, prefabricated concrete foundations, standing water, viewing platforms



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