# Marina Dock Age

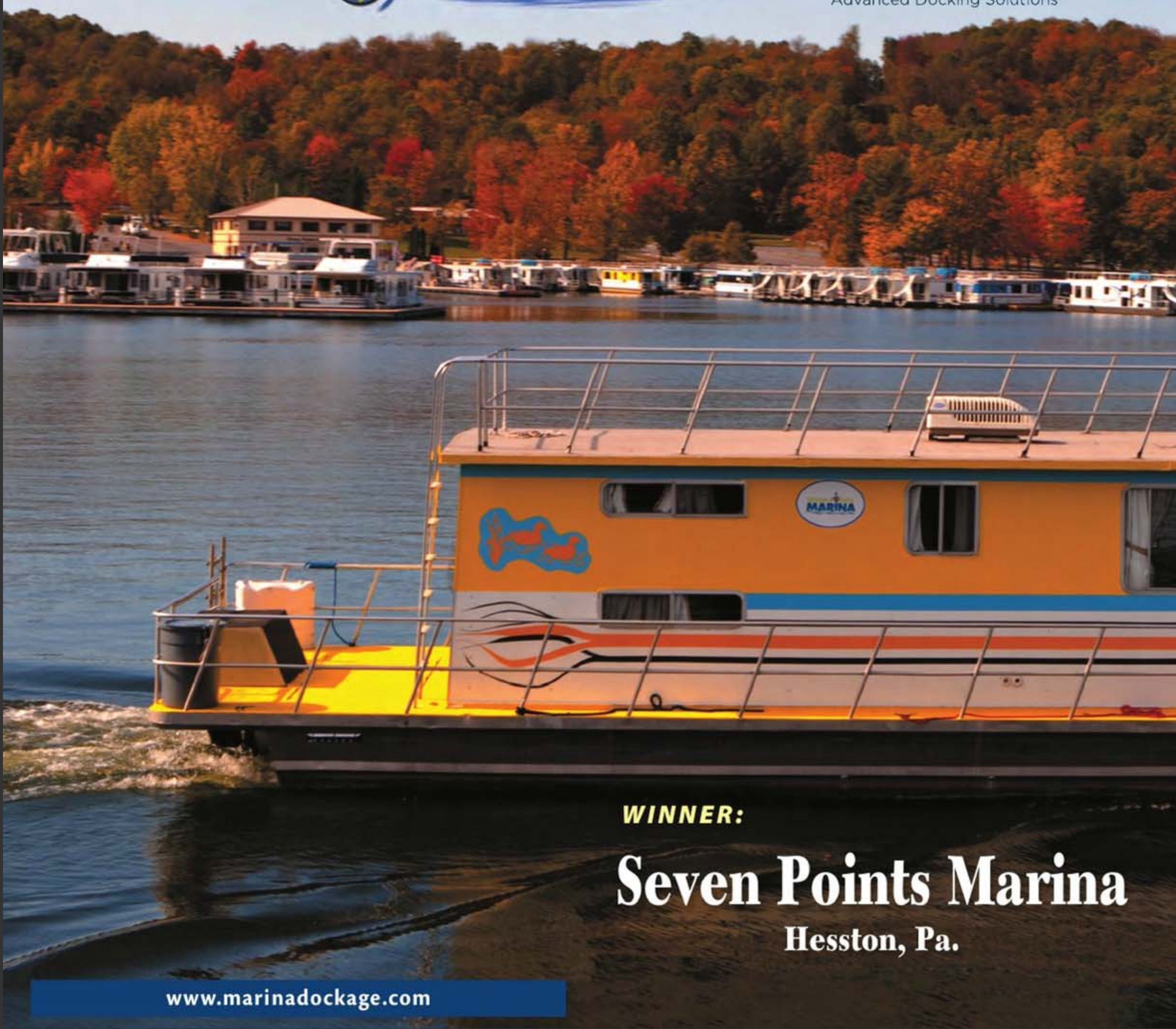
The magazine dedicated to marina & boatyard management

May/June 2011
$8.95


## 2010 Marinas of the Year

Prizes sponsored by MARINAS.com

Article sponsored by TECHNO MARINE™ Advanced Docking Solutions



**WINNER:**

# Seven Points Marina

## Hesston, Pa.

# Smoothing the waters: choosing the right wave management system

by **Robert Wilkes**

Picture a shiny new sailboat moored in an unprotected, fixed dock marina on Lake Washington in Seattle. While boaters could buy every type of rubber-snubber and fender in the chandlery, their boats still would take a beating from the chop.

Waves brewed up by the long fetch would multiply, sorcerer's apprentice-style, as they reflected off the lake's two floating bridges, and boaters would lie in bed at night listening to the wind and agonizing over bent lifeline stanchions, loosened cleats and damaged gel coat.

Thanks to modern marine engineering, boats no longer have to be tormented by choppy waves in the marina basin. Tenants demand millpond-still water inside marinas, and with current technology, marinas can give it to them. However, getting it right is not as simple as it seems. Many developers buy systems that are too much, too little or just plain wrong for their marina, and getting it wrong can be expensive or disastrous.

Jack Cox, senior coastal engineer with engineering firm JJR, said, "A concrete floating wave attenuator has no moving parts, but the engineering that goes into one is more like the Space Program."

## Proper design

"The right way to get a properly designed system is to start with a concept study from a qualified coastal engineer," said Russ Boudreau of Moffatt & Nichol. "The goal is to ensure protection from big wave events and coastal storms, but you also want the system to perform well in ordinary circumstances." Whether choosing a custom designed or off-the-shelf system, both engineers emphasized the importance of starting with performance criteria.

Engineers consider waves, currents, winds, tides, fetch, harbor topography, potential storm surges, ecological considerations, bottom conditions, and of course, the history of worst-case weather at the site. Worst-case weather is expressed in years, e.g., a 50-year or 100-year storm. Owners must balance reasonable storm protection against cost-effective construction costs.

## Wave energy

Most think of a wave as extending from trough to crest, but wave energy also extends down into the water. In deep water, wave motion is circular and energy tapers off with depth (see Fig. 1, *right*).

When wave energy approaches shallow water, it begins to "feel the bottom," beginning at 30 to 40 feet for waves with long periods (the time between waves). In shallow water, wave motion becomes elliptical and extends to the bottom (see Fig. 2, *right*).

Engineers study records for wind, tide and storm surge to determine the strength and direction of storms and the length of the fetch from each direction. Waves are measured by length, height and period. The engineers determine how "big" the expected "design wave" will be, and then specify the attenuator's required performance against the design wave. "It's not just about extreme conditions," said Boudreau. "The system has to stand up to near-constant motion without fatigue failure."

For floating wave attenuators, the size of the design wave isn't the critical dimension; it's the period. The longer the period, the more energy that has to be reflected or absorbed. Floating wave attenuators become impractical at periods greater than four seconds because they ride up on the wave rather than reflect it.

## Engineering a solution

"In addition to studying the geophysical and meteorological issues," said Boudreau, "we often use computer modeling or physical modeling in wave tanks to simulate harbor conditions and analyze solutions." Once the studies are completed, the engineers work with the manufacturing companies to tailor a system suited to the specific site.

"We don't have an 'off-the-shelf' solution for fixed breakwaters," said Boudreau. "We go from our concept study through to construction drawings and specifications. For floating wave attenuators, however, we create performance specifications and let the manufacturers offer a system that meets the requirements. Companies like Bellingham Marine already have the engineering capabilities and experience to design site-specific attenuator systems with proven performance and reliability."

## Fixed breakwaters

Fixed breakwaters vary from rubble-mound construction to vertical sheet pile walls, caissons and other solutions. Fixed

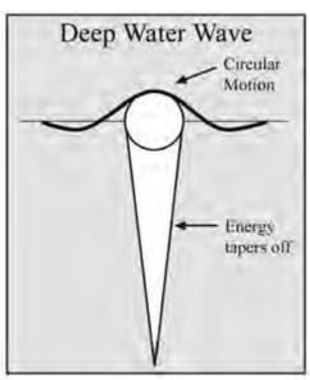



**Fig. 1.** *Wave energy tapers off in deep water.*

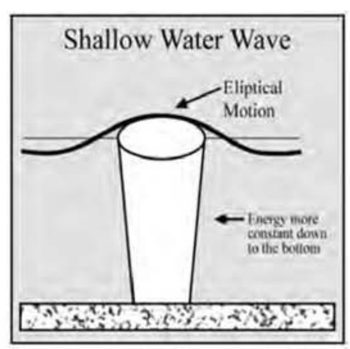



**Fig. 2.** *Wave energy begins to "feel the bottom" beginning at 30 to 40 feet for waves with long periods.*

breakwaters block wave energy—period. But they also have their drawbacks. They are very expensive and time consuming to build and can't be moved later during remodeling. As a practical matter, they need reasonably shallow water to be built economically. A marina that constructs a fixed breakwater in a semi-enclosed harbor must be aware of the impact on other marinas. The reflected wave, combined with other waves from open water, can be brutal.

Cox explained another concern about fixed breakwaters. "While most of the energy is reflected outward," Cox said, "some is forced downward in a wave phenomenon called clapotis, French for 'lapping of water.' The downward-moving energy can scour out eelgrass beds and can undermine the structure itself."

Fixed breakwaters can also be harmful to harbor ecology if they create anoxic (lacking in oxygen) dead areas of stagnant water. As the exception, engineers have designed fixed wall "baffle" systems that are open at the bottom to allow water to circulate, but these are difficult to build.

## Floating wave attenuators

Floating wave attenuators reflect and attenuate wave energy; energy that strikes the side is reflected. When waves are small, attenuators perform like a fixed wall. As wave energy increases, a portion passes under the wave attenuator. Much of that is absorbed by circulation patterns that create friction.

The performance of the wave attenuator is enhanced by its unique shape (see Fig. 3, *right*), which increases effectiveness while keeping structural size and weight manageable. In most conditions, even on a windy day, a protected marina will have tranquil waters inside.

Floating wave attenuators also have important ecological benefits. They attract undersea vegetation and bivalves (filter feeders) that clean the water and attract fish. They allow circulation under the attenuator, keeping the harbor oxygenated. They do not alter the ecosystem of a harbor the way a fixed breakwater does.

The most effective method to increase the performance of a floating wave attenuator is to make it deeper. But deeper attenuators put a huge burden on anchoring systems, which have physical limitations. The more practical solution is to make the attenuator wider. Widening the structure adds minimal stress to the anchoring system and enhances the beauty, strength and utility of the marina.

Bellingham helped pioneer the concrete floating wave attenuator, beginning with the first concrete docks at Shilshole Bay Marina in Seattle, built in 1958. "The concrete floating wave attenuator is the state-of-the-art in marina technology," said Southwest Manager of Project Development for Bellingham Marine, Eric Noegel. "Unlike a fixed breakwater, they offer revenue-generating opportunities for the operator, such as transient moorage, fuel docks and other uses."

*This wave attenuator's curved shape aids in wave energy absorption and diminishes the reflected wave.*

## The low bidder trap

The engineers offered two cautions regarding contractor bids. First, beware of unproven products that have great marketing and cool names, but don't perform. "A new one comes out about every three years," said Cox.

Second, public marinas with low-bidder rules may be disappointed if they don't manage bid specifications wisely. "A properly-engineered performance specification is the best way weed out an underperforming system," said Boudreau. "Specifications should include qualifications and experience standards for the manufacturer/contractor as well," he added.

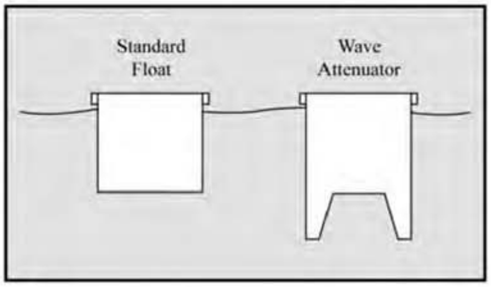



**Fig. 3.** *The unique shape of a floating wave attenuator absorbs wave energy as it passes underneath.*

Noegel also weighed in on the low bidder problem. "If municipalities aren't careful, they can find their hands are tied and be forced to award the contract to a low bidder whether they want to or not. We suggest bidders be required to show their engineering calculations when they present their bid. Make them prove their system will meet performance specifications."

Noegel suggested that municipalities adopt a point system that weighs factors such as experience, warranty, design approach, cost and so on. "That would give managers some latitude to select a wave attenuator that, at the end of the day, will do the job," he said, "while adhering to high standards for fairness and managing public funds wisely."

Even private marinas may be tempted to quickly settle for the lowest bid, but the money saved up front may produce an underperforming wave management system. Marinas must always consider performance specifications that are verified by a professional coastal engineer. ⚓

*Robert Wilkes has been reporting on the marina industry for more than 20 years. He lives in Bellevue, Wash., and can be reached via e-mail at* rcw@wilkescreative.com.