This aerial photo illustrates that even large, variably shaped lakes can be successfully lined when the right materials and proper expertise are employed.

Geomembranes in Golf Course Construction

With water storage and lake liners becoming more common, it is increasingly important to be aware of the choices in materials and construction methods.

by JOHN B. HEAP

WATER FEATURES play many roles on today's golf courses. The beauty and challenge of a well-placed pond or creek can improve the appearance of even the flattest, most mundane piece of land — and make it a better golf course in the process. In addition, water features provide critical irrigation water storage, control runoff and erosion, and provide habitat for birds and other wildlife. Therefore, it is no wonder that today's golf course architects pay a great deal of attention to the water features in their designs. And, since most new courses are constructed on less than ideal pieces of land, the vast majority of these water features are artificial in that they are constructed from scratch in areas where a pond or lake would not occur naturally. In many cases, the soil on the site is not suitable to hold water. In other areas, environmental concerns dictate that steps be taken to ensure that drainage water from the course does not make contact with underground water sources. All of these factors have resulted in much greater use of lake liners.

Although their use on golf courses has increased greatly over the past decade, geomembranes (pond and lake liners) have been used since the mid-1940s on a variety of applications. Some of the original uses involved the lining of agricultural ditches to limit seepage during the conveyance of water through man-made ditches and canals. Over the years, with increased awareness of pollution control and the need to use and protect our potable water resources, the industry has evolved into a complex field of appli-

cations. We now see lining systems under the majority of all new landfills in the United States. These systems are designed to gather liquid (leachate) and move it on top of the plastic barrier to a sump and/or collection area. At this point the liquid is pumped into a lined leachate holding lagoon and treated until the leachate has been tested to meet discharge standards. Most wastewater treatment lagoon systems are now lined with geomembranes to keep the effluent out of the groundwater while it is being treated.

Types of Lining Material Commonly Used in Golf Course Construction

For this article we will focus on the five types of lining materials used in golf course construction and the parameters that could be used to decide which lining product suits a particular project. As the remainder of the article will explain, liners vary greatly in their application, installation, and cost.

PVC

Application: PVC is the most commonly specified lining material in the industry. PVC is a highly flexible product that is manufactured by the calendering or extrusion process. Materials then are delivered in rolls to a fabricator who takes the 6'- to 8'-wide materials and fabricates them into large panels for delivery to the project. The use of large fabricated panels (15,000 to 20,000 sq. ft. per panel) allows field installation crews to install acres of lining per day while limiting the number of field seams.

The PVC panels are field welded together by two basic processes. The most commonly used process is solvent welding, which is very similar to welding pipe and basically melts the adjacent panels together. Now, with advanced technology in field welding, the use of wedge welders that apply heat and pressure to form a homogeneous weld are becoming the state of the art. Wedge welding provides excellent seam properties and reproducible welds, and it is faster and cleaner than solvents.

Design Notes: Since PVC is degraded by light, it requires a minimum of 12" of clean soil cover placed over the liner to function as designed. Slopes should be limited to 3 to 1, and cover soils should be walked in from the bottom of the pond to the top, always keeping a minimum of 12" of clean soil between your equipment and the membrane. For larger lakes, consideration for erosion and wave action should be taken into account. The use of rip-rap, concrete shore protection or synthetic erosion control protection is highly recommended. The majority of failures in PVC-lined golf course lakes is due to the failure to maintain proper cover over the lining system, resulting in UV degradation of the lining PVC materials.

The liner has been spread evenly across the surface. Notice the edge preparation, which ensures a good seal at maximum lake level. The footer at the top has been prepared for the installation of a concrete edge.

Reinforced Polypropylene

Application: Reinforced polypropylene (RPP) is becoming increasingly popular in the golf construction market. RPP is a reinforced product that can be fabricated into large panels of 15,000 to 20,000 sq. ft. It is UV stable and therefore requires no soil cover. It can be manufactured in various colors and is easily heat welded in the field for good quality field seams.

As with all lining used in golf construction, care should be taken to design a good edge transition from water to fairway. Many projects utilize a safety bench designed at 3' below the operating surface. This bench solves several potential problems. First, as the name implies, it allows someone who may fall into the lake an area on which to stand and exit the lake. It also allows the golf course contractor or architect the ability to create a nice looking edge around the lake, both protecting the lining from possible mechanical or spike damage and also creating an aesthetically pleasing finish.

Design Notes: RPP is used primarily on lakes where there is limited cover material or the slope design is too steep to hold a cover soil. This product is warranted for 20 years and is used widely in exposed wastewater treatment ponds. As mentioned above, it is highly recommended that a shore protection of some kind be used with all lining systems.

EPDM

Application: EPDM (ethylene propylene diene terpolymer) has been used in the roofing market for decades and has never had a failure due to material degradation. EPDM is extremely flexible, UV stable, and conforms well to irregularities in the subgrade. This product is beginning to gain acceptance in the golf industry and is being specified on projects where there is limited cover soil. This product is delivered straight from the factory to the project in panels that are 50' × 200' (10,000 sq. ft.). Field seams are made using an adhesive-backed seam tape. This process is very similar to patching an automotive inner tube. First you take an abrasive pad and roughen the material to provide a better gluing surface. Next, you apply a seam-priming adhesive followed by a 6"-wide adhesive-backed tape over the field weld.

Design Notes: EPDM is used in lakes where there is a need for an exposed membrane. This product is

warranted for 20 years and is gaining popularity in the custom waterfall and decorative pond market due to its high degree of flexibility. As with any exposed membrane, a safety bench and edge treatment are recommended.

High-Density Polyethylene

Application: HDPE is the most widely used geomembrane in the world. It has excellent chemical resistance, good UV stability, and is used more commonly internationally due to its availability and cost. HDPE is another UV-stable product and carries a 5-year exposed warranty. HDPE is a very technical product to install properly. Welding is done with hot wedges on long field seams, and extrusion welders are used on detail work and pipe boots. HDPE is delivered to the project directly from the factory in 22.5'-wide rolls and is custom fitted in the field to the lake configuration. There is a great deal more field welding due to the lack of factory fabrication.

Design Notes: HDPE is a good lining product, but it can be difficult to install in golf course projects due to its lack of flexibility and the technical nature of the fieldwork. If the project is specified around HDPE, extra care should be taken when choosing your installation contractor. Experience requirements should be a minimum of 5 million square feet, and the list of references should be checked carefully. This is not to limit the competition, but it is to ensure that the end product is installed satisfactorily and will meet its intended requirements. Again, with any exposed membrane, a safety bench and edge treatment are highly recommended.

Clay and Bentonite

Application: Natural soils have been used for hundreds of years to seal lakes and canals. Certain parts of the country have excellent clay soils, and if installed properly they can serve as an excellent lining system for lake construction. As with any construction project, care should be taken to install a clay liner properly, taking into account site conditions and material limitations. In areas that have a limited clay source, bentonite can be mixed with certain soils and compacted into place, forming a free swelling water barrier.

Design Notes: Clay and bentonite work well if local soil conditions, groundwater levels, and construction techniques are taken into account. These products do not carry any warranty, and as with any lining system they will fail if not installed properly. Consideration for slope erosion and wave action is even more critical with natural soils. Both materials need to be kept moist and protected from erosion and desiccation.

A great deal of manpower is required to pull the liner into place. Also notice how well the lake's bottom is prepared. The surface is compacted, smooth, and free of large sticks and rocks that could puncture the liner.

Subgrade Preparation

Regardless of the choice of lining products, subgrade preparation is critical to a successful project. The lining system will only be as good as its supporting structure. Care should be taken to match the right lining material with the local site conditions. Groundwater should be taken into account and, if present, it will need to be controlled both during and after construction. One method for controlling groundwater is to develop a French drain system under the lining system that allows the water to flow laterally under the lining without floating the lining. A good design for an underdrain is to pipe it through to the outside of the lake into a gravel sump. This allows the sump to run continuously during construction and, with the placement of an upright at this sump, the underdrain can be pumped if needed to relieve hydrostatic pressure and gas buildup under the lining system. All piping, railroad, and timber walls should be designed to work with the lining material chosen.

Conclusion

With the increasing pressure on our finite potable water supply, more and more facilities will be relying on secondary effluent for watering their golf courses. To provide better protection for underground water supplies, states are beginning to regulate the use of lake liners for projects that are using or will use secondary effluent for their irrigation water source. In arid areas with poor natural soils, the use of lake liners is mandated due to water conservation efforts, and it also gives the architect or golf course contractor the ability to create a water feature anywhere it will enhance the layout.

As with any construction project, the end result is only as good as the project specifications, materials, and quality of installation. Care should be taken when choosing your lining material based on your project-specific requirements. Always request references from your lining contractor to verify their experience in golf course lining construction. Remember that the end result will be only as good as your subgrade preparation, material selections, and installation contractor.

JOHN HEAP *is president and owner of Colorado Lining International (Parker, Colorado), a company that has been active in the liner industry since 1978. He can be reached at jheap@colorado-lining.com or 800-524-8672.*