



Capillary Concrete Bunker Specification & Installation Guidelines

The bunker liner product shall be CAPILLARY CONCRETE, a patented product, which is a specially formulated mixture of acceptably sized aggregate, various proprietary additives and water that must be uniformly mixed in a concrete mixer before installation. This creates a homogenously blended mixture that is poured from the mixer into heavy-duty utility vehicles, transported to the bunker and placed inside the bunker at a minimum depth of 2 inches (5 cm). The surface of the product is compacted with a roller and covered in plastic for a minimum of 24 hours to allow for adequate curing before sand is placed on top of the product. The result is a strong, homogenous and uniformly bonded product that allows water to drain through it at hundreds of inches per hour to prevent erosion and reduce contamination of bunker sand.

For added protection and peace of mind, Capillary Concrete offers a 10-year guarantee. The first five years are completely covered under our INSURED FINANCIAL GUARANTEE (IFG) POLICY provided by **Lloyds of London** insurance syndicate. This policy covers each bunker individually and protects the club, contractor and architect from failure for a period of 5 years. At the end of this 5-year term, the club can, at its option, purchase an additional 5 years of coverage, or do nothing and continue with an additional 5 years of our prorated product warranty.



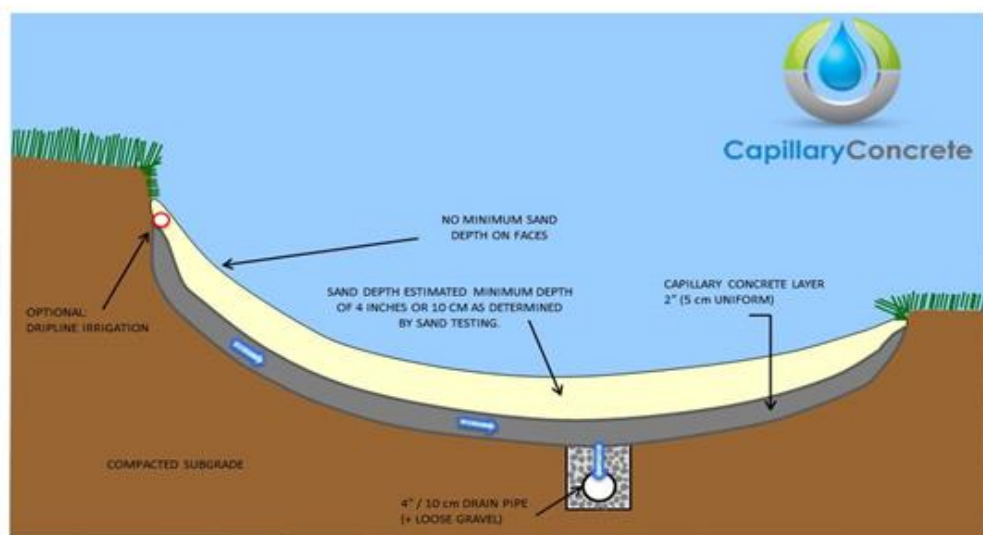
PRE CONSTRUCTION PLANNING

SUBGRADE PREPARATION, BUNKER SHAPING, AND DRAINAGE

Prior to installation of CAPILLARY CONCRETE, the CONTRACTOR, or OWNERS REPRESENTATIVE, or SUPERINTENDENT shall confirm that the perimeter area around the bunker does not channel excessive water into the bunker area, the bunker subgrade is positively pitched, stable under foot, smooth, compacted, free of debris and meets the ARCHITECTS design specifications. It must also be ensured that all bunker trenches have been excavated and constructed to specifications and drainage pipes and bedding gravel have been installed to the ARCHITECTS drainage specifications as dictated by site conditions. After installation, it must also be confirmed that the drainage system is functioning properly before installation of Capillary Concrete. It is recommended that a tracer wire be installed in all drainage trenches.

To maintain the pervious nature of the product, every effort should be made to prevent soil contamination of CAPILLARY CONCRETE during installation, curing, and prior to sand installation. Grassing around the perimeter of the bunker should take place prior to and be secured to the soil by roots or staples before the installation of CAPILLARY CONCRETE. In situations where grass cannot be installed prior to installation of Capillary Concrete, extreme care must be used to prevent soil contamination. In these situations the plastic must remain on the product until sand is installed. It is also recommended that when installing the sand in the bunker, an extra 4 inches of sand approximately one foot wide be placed on top of the Capillary Concrete around the perimeter of the bunker to reduce soil contamination as the sod is either installed or irrigated to establish rooting. If necessary, this extra amount of potentially contaminated sand can be removed prior to opening the bunker for play. (See Typical Installation Specification Drawing for details).

Certain installation requirements must be met and documented before the insurance company can approve and activate the policy. Those documents are part of this specification sheet but will also be sent separately via email for signing by the Owners Representative.



CAPILLARY CONCRETE - TYPICAL INSTALLATION
Capillary Concrete Bunker can be customized

2015-12-01

Capillary Concrete ®



THE BUNKER EDGE

Preserving the desired style or motif and reducing ongoing maintenance is critical to the success of any bunker restoration/renovation plan. Sometimes the topography causes bunkers to be located where large amounts of water sheet-drain into the bunker from the outside. This requires some extra thought to the edge design at these exposed areas.

The strength of Capillary Concrete allows the opportunity to protect the inside wall of the bunker better than any other product. Capillary Concrete has the ability to be shaped almost vertically at installation to get the least possible amount of soil in contact with the bunker sand.



Each project has a different “look” that is desired by the Architect or club. Some suggested ways to construct a protective edge are as follows:

1 – Soil or sod edge with natural grass

In this case, either the existing soil and grass, or sod is utilized as the edge of the bunker. The 2-inch (50mm) layer of Capillary Concrete meets the edge of the bunker. Rolling the sod over the face to cover the soil is an option. Another option that has been effective is stabilizing the perimeter of the bunker edge by using thick sod pieces laid with grass facing the inside edge of the bunker. The roots and thatch help to stabilize the edge and help keep the edge from collapsing. Place the sod pieces along the inside edge (grass side in), like in this picture, before installing the Capillary Concrete layer. On steeper greenside slopes, it is recommended that a notch approximately 2” (5 cm) deep and 2” (5 cm) wide be installed around the perimeter of the bunker where the vertical lip meets the floor of the bunker to create a “footer” to support the structure. (please ask us for detailed drawings as needed or desired).





2 – Sod edge with natural grass/sod with vertical Capillary Concrete at edge

Here, a vertical edge is created with a trowel, and carefully compacted on all sides. If the surrounding grass is utilized, we recommend undercutting the lip with a shovel to create a nice finish. If not, then make sure a fresh piece of sod is laid on top to cover the top finished edge of the Capillary Concrete.



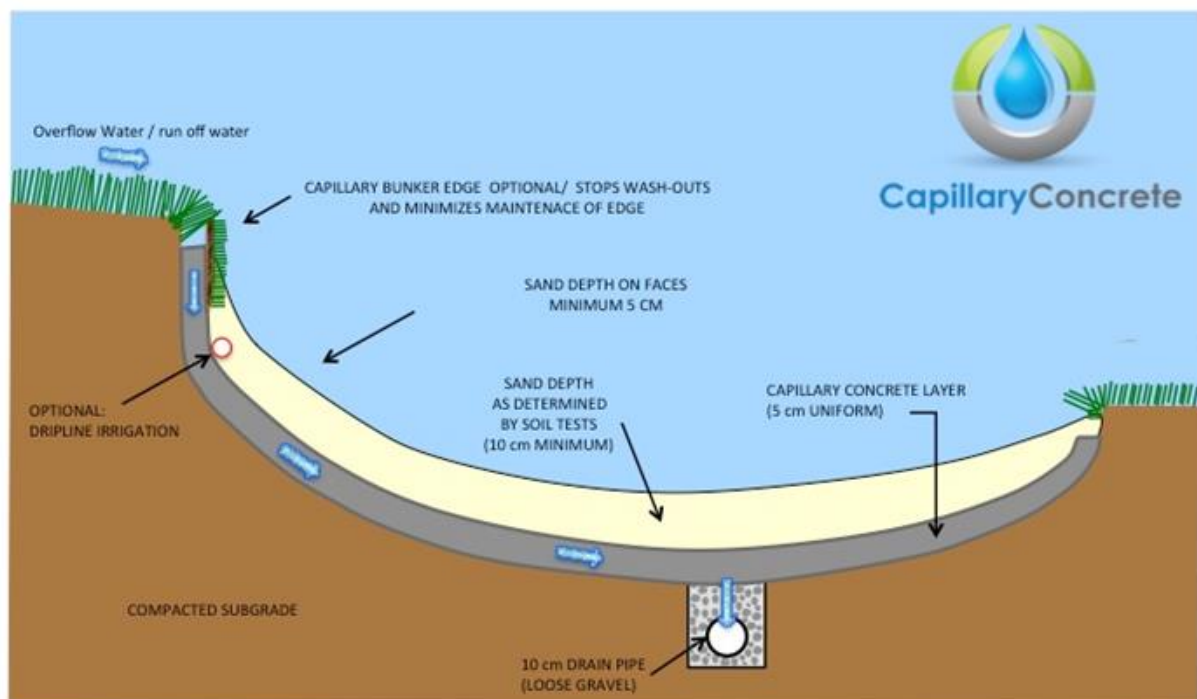


3 – Artificial edge inside for extreme sheet drain situations and minimum maintenance requirements

If the bunker, or part of the bunker, is exposed to large amounts of water that sheet drains into the sand, an artificial inside edge glued to the Capillary Concrete may be the solution. In this case, a small interceptor trench between the artificial turf and the natural turf is created to allow water to flow into the vertical Capillary Concrete layer and be transported to the subsurface drainage system.



This solution is also very maintenance friendly and requires minimum edging to keep the edge clean. Different materials are available to create the desired look to the inside edge, from a green/brown artificial turf to natural coconut fiber, etc. Please contact a Capillary Concrete representative for more information on your options.



CAPILLARY BUNKER EDGE

A golf bunker edge system that catches overflow water and stops any grass encroachment into bunker sand.

2014-11-10

Capillary Concrete ©



SAND TESTING

When uncovered, Capillary Concrete allows water to drain at hundreds of inches per hour. Once sand is placed on top of the product, the new water drainage limit will be the Ksat (saturated hydraulic conductivity) of the sand that covers the Capillary Concrete product. After gravitational water has freely drained from the sand, a certain amount of water will always be retained against the force of gravity. This is known as capillary water. Each sand will have a different amount of capillary water retention based on its particle shape and size. This capillary water retention can have an effect on playability and also help you determine how much sand is required in your bunkers to achieve desired playability based on the amount of moisture retained in the sand you select.

Sand particle size, color, shape, compaction rating, drainage characteristics, are subjective and exclusive to each project based on budget and desired playability at that particular golf course. As a result, Capillary Concrete cannot make bunker sand recommendations. However, we do recommend that the bunker sand that is ultimately selected falls within the USGA recommended bunker sand guidelines and that it bridges with the selected gravel to reduce migration of finer particles into the Capillary Concrete layer.

Capillary Concrete works with the testing lab, (Turf and Soil Diagnostics) to perform a Capillary Wicking Test to determine how high in the sand column water is held against the force of gravity. A 24-hour sand dry down test is also performed to show how fast the sand surface will dry. These tests will help you determine the depth of sand that provides the best playing conditions for your course.

CAPILLARY CONCRETE MIX DESIGN

In North America, the mix will most likely be delivered to the golf course in a ready mix truck with all additives homogenously mixed and ready for installation after a few simple steps. Before the project begins, Capillary Concrete's Product Manager will contract with a local ready mix supplier to formulate a Custom Mix Design specifically for this project using an acceptably sized aggregate with adequate void content and dry rodded unit weight that falls within the standards accepted by the USGA for drainage and greens construction. This gradation should also be compatible with the selected bunker sand.

In Europe and others parts of the world, we will likely use a tractor mounted PTO driven mixer to blend the aggregate with bags of our Capillary Concrete Admixture and water.

A custom mix design will be formulated for your project based on the aggregate used. Please ask for additional information regarding the mix design.










Pre-Construction Checklist and Instructions





Equipment And Tool Requirements

1	<p>Heavy-duty vehicle to haul mix from the ready mix truck to the bunker. Examples: Toro Workman, John Deere ProGator, Tractor and dump trailer, articulating loader etc. (Only needed if mix is produced in a ready mix truck.)</p> <p>Oftentimes, when mixing LWA (lightweight aggregate) the PTO driven tractor mounted mixer can be driven directly to the bunker edge.</p>	
2	<p>Plywood or similar to protect turfgrass and bunker edge and for building a ramp into the bunker if desired.</p>	
3	<p>A minimum of eight pieces of 4" (100 mm) to 6" (150 mm) diameter irrigation or drainage pipe cut into 2 inch (50 mm) lengths. Use these rings to maintain the 2 inch (50 mm) required minimum depth of the Capillary Concrete during placement. Remove the rings from the wet mix as you work out of the bunker. A metal probe set at 2 inches (50 mm) is also acceptable.</p>	
4	<p>Flat shovels for placement of the mix.</p>	



5	<p>A minimum of three plastic bunker rakes-the Accuform type bunker rake with a round head is preferred. The teeth can be used to rake and spread the mix to a 2-inch (50mm) depth, and the rounded back side can be used to smooth the mix before rolling.</p>	
6	<p>A minimum of two one piece metal extension handles with METAL TIPS. Telescoping handles are not necessary. Metal handles and tips are necessary to reduce flexing during rolling.</p> <p><i>Home Depot has an orange metal 5 ft. handle with a metal tip in the paint department. SKU#821-423.</i></p>	
7	<p>A minimum of two heavy duty 9 inch (23 cm) roller frames.</p> <p><i>Home Depot has a green Wooster Surelock handle that works well. SKU#150-345.</i></p>	
8	<p>A minimum of two 9 inch (23 cm) loop textured roller cartridges, if the textured roller can't be found, use a regular paint roller with the fabric removed.</p> <p><i>Home Depot used to call them Goop Loop Rollers. SKU#430-546.</i></p>	
9	<p>One 12 to 14 inch pool trowel. (30-35 cm)</p> <p><i>Home Depot Part# PT144BR</i></p>	



10	<p>Rolls of 6 millimeter Clear plastic (20ft x 100ft per roll) (6 x 30 meter)</p> <p>Use Black when temperatures are expected to be below 40 degrees F (4 °C) during installation and the night after. Purchase adequate plastic to completely cover all the Capillary Concrete bunkers completed in a day. The plastic can be reused for the entire project.</p> <p><i>Home Depot SKU#938-963</i></p>	
11	<p>6 inch (15 cm) metal staples to hold the plastic down after placement. Staples should be placed every 3 feet (0,9 m) round the perimeter of the bunker.</p>	
12	<p>Two 5 gallon (19 liter) buckets of water to keep rollers wet.</p>	
13	<p>A hose and quick-coupler with a misting nozzle and working shut off valve for misting of the product during installation.</p>	

A copy of this checklist will be sent as a separate document via email. That copy must be checked off, signed and sent via email PRIOR to the start of the installation process to bo@capillaryconcrete.com

- I. I have read and understand the Subgrade Preparation, Bunker Shaping and Drainage guidelines.
- II. I have read and understand the Sand Selection and Testing guidelines
- III. I have read and understand that the Capillary Concrete Mix Design may vary from project to project based on aggregate and environmental conditions and will be finalized prior to the project start date by a Capillary Concrete representative.



INSTALLATION INSTRUCTIONS

NOTE: CAPILLARY CONCRETE should not be installed when temperatures are expected to be below freezing within 2 days of installation. During hot weather, windy, or low humidity conditions, the product will set up faster and caution must be exercised to maintain acceptable moisture levels of the mixture and bunker base prior to installation. A light misting may be required during the installation process.




The table below describes the installation process.

-Instruction items A1 through A6 are specifically for mixing Capillary Concrete using a tractor mounted PTO driven mixer, aggregate and our admixture bags.



-Instruction item B1 begins the installation process for Capillary Concrete when using a ready mix concrete truck.

-Instruction items 2-10 are common installation guidelines for both processes.

THE PTO MIXER/AGGREGATE/BAG OPTION INSTALLATION PROCESS BEGINS HERE.

A1	When using LWA (lightweight aggregate), the LWA bag or pile must be irrigated for at least 45 minutes not less than 12 hours prior to installation. Local stone does not have to be irrigated prior to mixing.	
A2	Before mixing, spray a light coating of approved oil on the mixer and tools and bed of the vehicles used to haul the mix. This will make cleanup easier.	
A3	Fill the mixer with your aggregate to the fill line located on the inside of the mixer. Most mixers are preset for 750 liters of aggregate. The aggregate should never be so wet that water drips from the bag or pile. Before adding the Capillary Concrete Admixture bags to the aggregate, every attempt should be made to eliminate the free water from the aggregate as this excess water has not been factored into the specified mix ratio.	







A4	<p>BEFORE MIXING-ensure that the safety screens and all other safety devices are attached according to the manufacturers specifications.</p> <p>The proper batch ratio is six bags (150kg) of Capillary Concrete Admixture to 750 liters of aggregate. With the tractor in low idle, and the mixer arms turning slowly, place the unopened bags on top of the mixer and open the bags so the mix falls uniformly onto the aggregate. DO NOT ADD ADDITIONAL WATER AT THIS POINT. Mix for 3 minutes to allow the Capillary Concrete Admixture powder to completely coat the aggregate.</p>	
A5	<p>Now we can add water to the mixture. The base rule is 75 liters of water per 750 liters of aggregate and 6 bags of Capillary Concrete Admixture.</p> <ul style="list-style-type: none"> - Remember - the aggregate likely has some moisture in it (the LWA was saturated prior to use). You may not need to use all 75 liters of water and NEVER ADD ALL THE WATER AT ONCE. - Until you are comfortable with the amount of moisture in the aggregate and can duplicate ideal batches, we recommend adding 1/3 of the water at first and letting it mix for 3 minutes before adding more water. - Check the mix consistency as indicated in part A6. Then add the next 1/3 of the water. Multiple revolutions of the mixer are needed to thoroughly distribute the water throughout the mix and after the second 1/3 of water is added, you will want to be careful not to add too much water at one time now. The mix should have a shine to it that resembles melted chocolate. Never let it get soupy. After the last water is added to the mix, allow it to mix an additional 3 minutes before checking the mix and discharging. 	 <p>-Once you know how much water is required to produce an ideal batch, you can add that amount of water at one time and mix for 4 minutes before discharging.</p>





A6	<p>Before discharging into the haul vehicles, Check that the consistency of the mix is correct. Turn off the mixer and take a handful of wet mix and squeeze it in your hand. Open the hand vertically as if shaking hands with someone and watch the mix on the surface of the hand. If there is wet paste and aggregate particles or LWA stay on the hand, the mix is right. The Capillary Concrete mix is more stable and does not flow like normal concrete. The mix should be “shiny” and “wet” looking, but not runny like soup, so it can be applied to steep bunker faces without concern of it falling down the face.</p>	
THE READY MIX INSTALLATION PROCESS BEGINS HERE		
B1	<p>When the ready mix truck arrives at the job site, you will need to ensure the correct consistency of the CAPILLARY CONCRETE before installation can begin. To do this, perform a HAND SQUEEZE TEST.</p> <p>Discharge about 5 gallons of the CAPILLARY CONCRETE mixture into the utility vehicle you are using to haul the mix to the bunker. It should be shiny and look like melted chocolate and rock. Take a handful of the mix and squeeze it in your hand and release. The paste must be sticky enough for the aggregate particles to adhere to the vertical surface of your hand. If the paste is dry and powdery, the mix is a little too dry and you need to add water to the mixer truck. NEVER ADD MORE THAN 3 GALLONS OF WATER AT A TIME (unless otherwise instructed by an onsite Capillary Concrete Representative) and ask the driver to turn the drum a minimum of 12 revolutions before checking the mix again. Continue this process until mix has the feel of melted chocolate. Be careful not to add too much water. It’s always better to add a little at a time.</p>	<div data-bbox="810 779 1345 1178" data-label="Image">  </div> <div data-bbox="1358 786 1449 1171" data-label="Text"> <p>We cannot take the water out once it has been put in the</p> </div> <div data-bbox="810 1178 1449 1462" data-label="Text"> <p>mixer. The paste should NEVER be drippy and runny when you perform the hand squeeze test. The mix should always have the consistency of melted chocolate. Continue to monitor the consistency as you install. An additional gallon of water may be required after a few loads have been installed. If so-ask the driver to add one gallon and rotate the drum 12 times before discharging more mix.</p> </div>
2	<p>If the subgrade is dry, it should be lightly misted prior to placement of CAPILLARY CONCRETE. Do not let the floor get muddy during installation.</p>	



3	<p>Once the batch is properly mixed, begin in one corner of the bunker by spreading the mix to a depth of 2 inches (using depth gauge rings) Use plastic bunker rakes to level the product.</p>	
4	<p>Use the textured roller to finish and compact the surface. The entire surface of Capillary Concrete must be lightly compacted to provide a smooth surface and bond the product together. Keep the roller damp during the rolling process. It is important to work quickly during this step. The sooner the product is smoothed and rolled the better. Any footprints can be raked out and leveled with the plastic bunker rakes and rerolled to make it smooth.</p>	
5	<p>The edge of Capillary Concrete must be no less than 2 inches thick. A hand trowel should be used to compact and finish the edge of the material around the bunker edge. (If desired, this is also the location of the drip-line irrigation option) Care must be given to prevent loose aggregate pieces from adhering to the exposed soil edge. Any loose pieces should be removed immediately.</p>	
6	<p>Once an area or batch section is finished, it must be covered immediately with 6 mil clear plastic. Covering is important to reduce moisture loss and improve curing and strength of the mixture. In hot and windy conditions this is an even more critical step than on cool, cloudy and calm days, where evaporation rates are less.</p> <p>Place staples in the plastic every 3 feet around the perimeter of the bunker and as close to the mixture as possible to reduce air between the plastic and mix. If there are seams between plastic pieces, use something heavy to hold the seams down. New bunker sand is great for this.</p>	 <p>Remember we want to reduce the amount of air getting to the product as it cures. This step also keeps water from getting on it.</p>



7	The plastic must remain on the product for 24 hours or remain until bunker sand can be installed. This will keep the produce clean and debris free.	
8	When the CAPILLARY CONCRETE mixture is solid to the touch (minimum of 24 hours after installation), the base of the bunker shall be cleaned with a backpack blower and a broom to remove any loose surface pieces that may not have adhered during the rolling phase of the installation. Check the edge for loose pieces as well and remove them from the soil edge.	
9	Moisten the Capillary Concrete now and confirm that water rapidly drains through the product. This is a very important test to secure the function. Do not “blast” high pressure water on the freshly installed Capillary Concrete - a steady stream is recommended. See the film; The Test of Drainage	
10	Bunker sand can now be installed to the desired depth using a conveyor, loader or utility carts etc. Do not drive directly on the new Capillary Concrete during sand installation. It is recommended to begin sand installation on an edge and push the sand out across the bunker while keeping vehicles on plywood on top of the sand layer. Once the sand has been installed, saturate the sand with water. Never at any time shall the bunker liner be allowed to dry out completely before covering with sand. This moisture will help the product continue to cure and help the sand firm up.	

If requested by the CONTRACTOR, OWNERS REPRESENTATIVE, SUPERINTENDENT, or GOLF COURSE ARCHITECT, Capillary Concrete will provide a technical representative for installation assistance and consultation for one (1) full day on site at the start-up of a Capillary Concrete installation for the cost of basic expenses and related costs. Additional days of consultation may be requested at the same expense rate. Please provide a minimum two (2) weeks notice to arrange this service. For more specific questions contact Capillary Concrete at 847-337-0808 or ted@capillaryconcrete.com.

Please visit www.capillaryconcrete.com for more information.

[Link to Bunker install instructions here:](#)

[Do not hesitate to contact any Country representatives at our homepage here:](#)

[See here how easy it is – Capillary Concrete installation video from The Honors Course, USA](#)

[The Capillary Concrete Installation instruction document. Step-by-Step.](#)

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