Autopsy of a bunker

As technology has improved dramatically over the last 20 years, does bunker maintenance still have to be costly and time-consuming? 'Absolutely not' says engineer Richard Allen, who details key findings he has learnt from working on major bunker construction projects

Ask any golfer to comment on the health of his or her golf course and in their reply it is odds-on that bunkers will be identified for treatment. Is this another example of the well-known 'Augusta Effect'? Or is it true that bunkers are often unfit for purpose, justifying investment to aid recovery or restoration? Engineer Richard Allen followed his passion and altered his career path, examining and analysing the causes, rather than treat the symptoms of bunker ailments. This report presents a short summary of some of the key findings and lessons learned over the last 10 years of international bunker construction.

'All bunker styles, apart perhaps from the shallow dish, produce maintenance tasks, sometimes disproportionate to their advantages.' F.W.Hawtree. The Golf Course, 1983.

This very accurate and efficient statement provides a clue to the origin of the invention of synthetic bunker revetments. When a well-respected, established local golf club began converting their irregular shaped, high edged, sand faced bunkers into flat shallow dishes, Richard, a lifelong golfer, wanted to know why. It emerged that the club's greens' committee had taken the firm view that the aesthetic value of these 'Colt' style bunkers was not worth the extra maintenance cost.

Edge contamination has been underestimated

Building a fully sealed EcoBunker

Disappointed by the outcome, Richard emerged determined to find, and if necessary invent, construction methods which would make a range of bunker styles with affordable maintenance regimes available to all golf clubs. The timing could not have been better. For some unknown reason, the golf industry, which has done wonders in agronomy over the past decades, by comparison, had not paid a great deal of attention to bunker construction and maintenance. Soon after the turn of the millennium, however, new bunker products, improved fabric liners and then pioneering 'hardscape' options were emerging fast. Golf clubs appeared to be eager to adopt new bunker technologies, so this was a great opportunity. Or was it?

In Richard's view the mechanics of how a bunker performs are complex. There are so many variables in the site, materials, local ground conditions, amount of play … the list is almost endless. However, there are three distinct aspects, which if all addressed correctly, should lead to consistent, aesthetically pleasing bunkers with an acceptable maintenance burden. These aspects, which are often interlinked, are drainage, sand purity and edge construction.

Drainage

"Pete Dye once told me that 95 per cent of the job is making drainage look good, and there's a lot of truth to that." Tom Doak.

Richard's professional background is as a civil engineer who specialises in drainage, flood risk analysis and development infrastructure design. A key skill in this field is the ability to design infrastructure that can be easily maintained. Why? Because much of the infrastructure is built privately, but with the ultimate aim of a handover to councils or drainage agents under relevant Acts of

Parliament (for example The Highways Act 1980 or the Water Industry Act 1991). Councils must be wary of adopting expensive liabilities, so the original designer (Richard and his team) must be able to design efficiently but also with maintenance and whole life performance at the forefront of their minds. How has this skill been applied to bunker drainage?

'All in all, since golf is played on many sites other than the ideal light sandy soils of heath or links land, drainage is still a far more important factor, in relation to all-year-round play, than almost any other consideration.' Jim Arthur. Practical Greenkeeping, 1997.

Flooded bunkers are an extremely common sight for golfers.

Furthermore, due to the current rules of golf they present extra problems. Competition committees are often faced with the highly unsatisfactory option of temporary rulings, even in major amateur and professional events, where bunkers are so full of water that they cannot afford relief in the conventional manner. Given the observable changes in weather, with more, short intense downpours, this phenomenon is likely to increase, unless bunker drainage is improved.

Richard believes that applying a few inexpensive standard engineering industry techniques would help greatly in many instances.

STRI judged Richard's drainage design to be water management project of the year

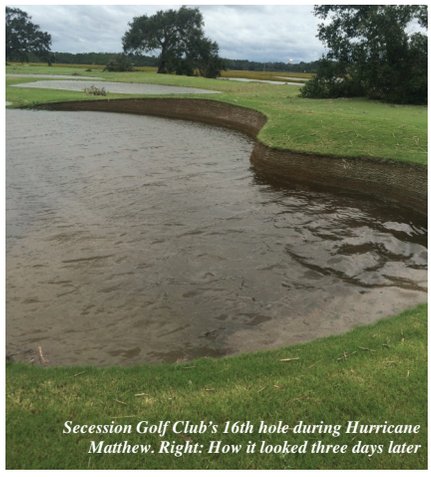
The first one is simple: Having immediate access to as-built drainage plans. It is surprising how many golf courses don't have an accurate plan of where their drainage is, or if they do, it can't be found when it is needed. Sometimes all the information is accurately stored in the memory of a long-serving greenkeeper, but what happens if he is on holiday at the time of an emergency, or worse, retired or moved on to a new opportunity? Many man and machinery hours are wasted alongside a flooded bunker as the location of the outfall is debated, and unsuccessful messy exploratory holes are dug. If an as-built plan is not available, much money can be saved by a short-term investment in a drainage survey. Furthermore, with the advent of GIS and mobile applications, it is then relatively easy for greenkeepers to update their digital records as drainage networks are altered or extended.

The second is designing for easy access and inspection. If there is no easy access to the positive drainage and outlet, it is usually difficult to quickly determine the cause of the bunker ponding. Time is money, so a rapid identification of the problem is preferable, and it can help return bunkers to play much more rapidly, benefitting the paying customers. Accessibility can be achieved very easily by the addition of mini inspection chambers and rodding eyes. Richard has incorporated rodding eyes and inspections chambers on his projects (they only cost between £20 and £50 each) and is surprised how rarely he encounters them on the many site visits he undertakes. "This simple approach allows the greenkeeper to quickly determine if the pipe is flowing and ensure it is clear. The problem can often be solved this way with no mess or wasted time. If the pipe is clear but not flowing then the problem is that water is not entering the pipe, so only then will more intrusive, time consuming work within the bunker be necessary," he said.

Finally for golf courses which rely on soakaways, but where infiltration potential is marginal, Richard recommends that where space is available the soakaways are located outside the bunkers. If the soakaway is under the flooded bunker it is impossible to determine what the problem is without undertaking excavation. On the other hand, if the soakaway is easily accessible it can be quickly determined whether the soakaway needs de-silting, or the pipes are blocked, or the pathway from bunker sand to outlet is compromised. The uncertainty is removed, ensuring that remedial efforts are focussed on the correct solution straightaway. Richard also recommends simple inexpensive infiltration tests, which if carried out using established engineering procedures (*BRE Digest 365*) can help with the design of soakaways, appropriate to the site. "This takes the luck out of soakaway construction," he commented.

Sand purity

Bunker sand is expensive. And it is not likely to get any cheaper in the future. Most golf clubs will be aware that many of the sand



Secession Golf Club's 16th hole during Hurricane Matthew. Right: How it looked three days later

quarries in the UK that used to deliver top quality bunker sand have closed. Sand needs to be delivered longer distances, greatly increasing the cost. This is not only a UK phenomenon. A technical article in *The Conversation* on September 7, 2017, predicts a worldwide sand shortage. At current rates, Vietnam, for example, might run out of construction sand by 2020.

Cost is not the only concern. Contaminated bunker sand doesn't drain as well, stones in bunkers are an unwanted hazard, much complained about, aesthetics are compromised and consistency (a word often uttered by disgruntled golfers) is more difficult to achieve. Therefore we should be looking at ways to extend the life of the sand we install into bunkers. How can this be done?

Traditionally it was thought that all contamination came into the sand from below. This is not 100 per cent accurate, but nevertheless, a whole new industry in bunker liner products has grown, and seemingly accelerated over the past 10 years. Some soil conditions mean that a liner isn't needed, but usually, if a golf club wants to extend the life of their bunker sand they will need a liner of some sort. How do you choose which one to use? In Richard's view this is a difficult decision because the choice is now so wide, and so is the price range but, following working with most of the main liner products on the market he feels able to give some advice: "It's possible to split the market into two segments: geotechnical fabrics and aggregate based 'hardscapes'. The fabrics are

a lot cheaper to buy, and can be installed easily in-house, but they have developed a poor reputation. In most instances this is unfair, because they will normally perform very well if a minimum cover of sand is maintained in accordance with the manufacturer's specification. This requires regular monitoring of sand depth and adjustment. If a golf club doesn't have the resources to carry this out consistently then it should probably consider alternatives, but it should be noted that some of the world's leading courses manage very well with fabric liners," he explained.

Turning to the hardscape options Richard commented: "These are generally more expensive, and some can only be installed by the proprietor. In the long run though, they may not work out quite as expensive as they seem, because as a whole they do require very little maintenance. There have been some failures in the past, but the industry now seems to have learned from this, and some products come with generous warranties. This added reassurance is something I would look at if it was my golf course."

EcoBunker, Richard's company, is independently arranging and installing liner tests for clients that wish to compare the performance and member feedback on contrasting options at their golf courses. Liners are a major investment, so spending a relatively small sum on a trial may be a prudent way forward for a golf club.

Bunker edges and faces

Referring back to the start of this report, the unfortunate removal of bunkers with raised lips and irregular shapes was the spur that led to Richard's invention of the method of layering synthetic turf to form resilient but

natural looking bunker edges. What benefits does this edging system bring?

Firstly, combining a resilient, permanent edge with an undersand liner creates a sealed 'tank' which drains water but retains the sand. Sand purity is extended, as silts and stones cannot enter the bunker for the sides. This was an underestimated source of contamination until 'stacked synthetic sod', as it is termed in the USA, entered the scene.

Secondly, the costs savings are considerable, on all styles of golf course. For example, its widely known that natural turf revetments only have a practical lifespan of four to five years. By contrast, the EcoBunker systems are guaranteed to last for 20+ years. Southerndown Golf Club (pictured above) was the first golf club to commit to a full course renovation back in 2012. Having now completed the last of 80 bunkers in the spring of 2017, the club is now collecting data that proves it is saving the predicted £20,000 per annum on bunker maintenance.

Finally, aesthetics can be maintained. The product enables designers to create beautiful edges and faces without the worry of natural erosion, burrowing animals or careless greenkeeping practices from spoiling the effect. In 2016 and 2017 the true resilience of the construction method was tested by the most extreme weather events imaginable. To conclude this item, who better to comment than Michael Gonzalez, president of Secession GC, Beaufort, South Carolina:

"You'll be pleased to know that our EcoBunkers at Secession have now survived hurricanes Matthew (2016) and Irma (2017). Many filled with seawater. Skim the silt, add an inch of sand, a little raking and we're back in business."

It is possible to build bunkers that will have a healthier life!