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This publication includes lecture notes of papers presented at the 2002 New Jersey Turfgrass Expo. Publication of these lectures provides a readily available source of information covering a wide range of topics and includes technical and popular presentations of importance to the turfgrass industry.

This proceedings also includes research papers that contain original research findings and reviews of selected subjects in turfgrass science. These papers are presented primarily to facilitate the timely dissemination of original turfgrass research for use by the turfgrass industry.

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ATHLETIC FIELD PROBLEMS AND THEIR SOLUTION IN THE UNITED KINGDOM

Stephen Baker[1]

The main sports played on athletic fields in the United Kingdom are soccer and Rugby. For both sports, the main playing season starts at the end of the summer, continues through the fall and winter, and finishes in the spring. The United Kingdom is at a relatively high latitude (51 to 58°N), and during the winter, rainfall greatly exceeds evapotranspiration. There is virtually no grass growth for 3 months, and shade can be a major issue. The fact that the playing season coincides with the worst period of the year for grass survival causes some unique problems in terms of turf provision. The objective of this paper is to review solutions to these problems, concentrating primarily on the provision of playing surfaces for professional sport and considering, in particular, construction methods, the use of reinforcement systems, undersoil heating, and problems of shade in stadia.

CONSTRUCTION METHODS

In the major soccer stadia, the field is usually constructed as a sand-dominated rootzone over a gravel drainage layer. Typically, the rootzone depth is 250 to 300 mm and the drainage layer (consisting usually of 5 to 10 mm gravel) is 100 to 150 mm in depth, with an intermediate layer of 50 mm of coarse sand or fine grit. In some cases, the rootzone layer is divided into an upper section (e.g., 125 to 150 mm) of amended material with pure sand underneath. Typical rootzone particle size analyses from three Premier League soccer grounds are given in Table 1.

Clubs in the lower leagues are less likely to have a fully reconstructed profile and thus have retained the original soil on the site. However, normally a sand-dominated surface layer will be used in conjunction with intensive under-drainage or alternatively slit drains will have been installed to assist surface drainage.

TURF REINFORCEMENT

As soccer and Rugby are played from August into May, this means that a large part of the season occurs at a time when grass growth is negligible. The resulting thinning of grass cover combined with the fact that most modern rootzones are sand-dominated for drainage purposes means that surface stability is a significant issue on athletic fields used for professional soccer. Reinforcement systems are, therefore, now widely used.

Four reinforcement systems are currently known to be in use in fields used for professional soccer in England:

i) Fibresand consists of polypropylene fibers typically around 0.1 mm in diameter and 35 mm in length. These are blended in a mixing plant into a sand-dominated rootzone mix with a fiber rate of 0.25 to 0.35% on a weight basis being used for most sports turf applications. Fibresand is probably the most widely used reinforcement system in the United Kingdom.

ii) The GrassMaster system consists of fibers that are punched into the rootzone to a depth of 200 mm and at a 20 mm spacing. This is now used at several clubs including Liverpool, Aston Villa, and Chelsea.

iii) Mesh elements are discreet pieces of oriented polypropylene mesh measuring 100 X 50 mm with apertures of 10 X 10 mm which can be mixed into the rootzone material. They are currently used at Manchester United.

iv) AstroGrass is based on a woven, polyolefin fibers with a pile height of 70 mm on a partially

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Table 1. Particle size analyses of the rootzone material from three Premier League soccer clubs in the United Kingdom.

	Diameter (mm)	Leeds United	Aston Villa	Arsenal
Very coarse sand	2 – 1	1	Trace	3
Coarse sand	1.0 – 0.5	9	2	26
Medium sand	0.50 – 0.25	57	28	49
Fine sand	0.250 – 0.125	25	59	13
Very fine sand	0.125 – 0.050	3	7	2
Silt	0.050 – 0.002	3	2	4
Clay	<0.002	2	2	2

biodegradable backing into which the rootzone material can be worked and grass sown. It is currently used at Oxford United.

One major advantage of the incorporation of reinforcement materials into a rootzone is to increase the strength. Fibresand, for example, can increase the traction (or grip) available to the player, and the presence of fibers also helps to prevent the kicking out of divots, and therefore the playing surface is less likely to cut up.

The presence of fiber and mesh elements may also help to reduce the rate at which compaction builds up in a rootzone. For example, in a study with Fibresand, we found that the total pore space and the volume of air-filled pores both rose slightly as the rate of fiber inclusion increased, and there were larger increases in water transmission rates with increasing fiber content. Similar results have been observed with mesh elements.

Reinforcement materials are not a panacea for all problems on turf areas. In many cases they greatly help with specific problems, but careful thought should be given to possible disadvantages as well as their benefits for each situation. The problems that can arise with reinforcement materials will depend on the nature of the product that is used. Disadvantages, however, include difficulties in obtaining good surface levels, problems of grass establishment on some materials, or adverse effects on playing quality (e.g., problems of excessive hardness).

In addition, the effects on maintenance should not be forgotten and more rigid materials may, for example, prevent vital aeration work, thus negating any value that they have for the protection of soil structure. Furthermore, it is important that organic and mineral material should not accumulate within the reinforcement and thus contribute to sealing of the turf surface.

UNDERSOIL HEATING IN THE UNITED KINGDOM

With the vast improvements that have taken place in the construction of athletic fields in the last 15 years, it is now probably cold weather rather than heavy rainfall which poses the biggest threat to match cancellations in the United Kingdom. If clubs lose games to frost and snow, it can cause problems with cash flow and, from the playing point of view, there can be major problems of fixture congestion late in the season.

Development of undersoil heating

In the United Kingdom, the first trials on undersoil heating started in 1947 at the Sports Turf Research Institute. These trials were based on plastic coated electric warming wires installed at 150 mm depth and 150 mm spacing using a modified mole plough. A system of electric heating cables was installed at the Scottish Rugby Union ground in Edinburgh in 1959 and this was followed by a similar system on a Rugby field in Leeds in 1963.

The electric cables at Edinburgh and Leeds and a warm air system at Arsenal FC in London were all eventually replaced by warm water systems, and this form of undersoil heating has been used on all recent installations. It is estimated that at least 50 stadia in the United Kingdom have heating systems below the playing surface.

Warm water systems

Modern warm water systems generally consist of 20 to 25 mm diameter polyethylene pipe installed at 250 to 275 mm centers that are connected to a gas or sometimes oil-based boiler.

Temperature sensors usually in the coldest part of the field are used to activate the system, although manual control is also possible with decisions being made depending on the severity of weather forecasts. Heat flow through the pipes usually starts at the coldest part of the field (e.g., shaded areas) to maximize efficiency, but some of the more recent installations have pipes laid on a zonal basis so, for example, frost can be removed from shaded sections without the need to heat the rest of the playing surface.

Heating pipes can either be pulled into the ground (e.g., using a four-wheel drive tractor) or, more recently, a number of systems have been laid directly onto the intermediate layer before the rootzone is spread. Installation costs are now around $200,000.

Running costs vary considerably with this being influenced by the type of system and the temperature required, with figures obviously being greater when the system is running at full capacity to melt snow. However, for frost control, when minimum temperatures are around -4°C, a typical cost per match would be $4,500 with the system running from Wednesday to Friday night for a game on the Saturday.

Management problems

Although undersoil heating is an excellent way to clear frost and snow, there can be problems with its installation and use that should not be ignored. Firstly, with some of the earlier systems there were reports of the soil baking around the wires and pipes. This may have in part been a function of heavier, clay-rich soils into which the early systems were installed, and this seems to be less of a problem on today's sand-dominated rootzones.

Secondly, shortly after some of the earlier systems were installed, it was noted that although frost was no longer a problem, the risk of losing games to waterlogging increased, as the presence of shallow sub-surface pipes restricted deep aeration. This is less of a problem on more recent installations where rootzones are more free draining and installation depth can be more closely controlled.

With more modern systems particularly in sand-dominated rootzones, there can be problems of the surface drying out if the undersoil heating is used for long periods of time. This creates a management dilemma of having to add water to improve playing quality and stability in conditions where air temperatures are very low. Furthermore, there have been reports of shallow rooting on fields where undersoil heating has been used regularly over the winter period. Although this may in part be attributable to other factors such as shade or poor aeration, the grass plant would certainly be getting very confusing messages with low temperatures at its leaves and high temperatures at its roots.

Although undersoil heating is a boon in ensuring that games are not lost, there can of course be major difficulties in terms of access to the ground and problems of parking following heavy snow, which may mean games are postponed even though the field is perfectly playable.

Finally, there is always the unfortunate side-effect that the availability of undersoil heating means that in prolonged cold weather, the main stadium field gets very heavily used for training sessions at the worst time of the year, as there are simply no alternative practice areas. However, in the last few years some of the wealthier clubs have now included undersoil heating systems or frost covers at their training grounds.

SHADE PROBLEMS AND MANAGEMENT RESPONSES

Shade is a significant problem in United Kingdom sports stadia for three main reasons:

a) Latitude: mainland United Kingdom extends from 51 to 58°N. This is comparable to the southern part of Hudson Bay in North America and, because of the low sun angles, several major stadia get no direct sunlight on any part of the field in December and January.

b) For soccer and Rugby in particular, the playing season continues through the winter months.

c) For reasons of ground safety and spectator comfort, there has been a considerable increase in the number of large stands with extensive roof areas surrounding fields at professional clubs in the United Kingdom.

Effect of shade on the grass plant

Increased shade causes a number of changes in the physiology of the grass plant, producing longer leaves that are proportionately narrower and lighter in weight. The rate of leaf production also slows, especially at very low light intensities. Shade also has a major effect on the proportions of top growth to root growth. In poor light conditions, the grass plant maximizes its resources by producing as much leaf matter as possible to aid photosynthesis at the expense of its root system.

These changes are very important to the health of a football field. The wear tolerance of a grass is closely related to its rate of production, and thus any factor that reduces growth affects its ability to withstand wear. The effect of light on root production is equally important. If root growth is reduced, the turf has a greater propensity to be kicked out. This is a particular problem in modern athletic fields that have high sand content for which good root development is very important to maintain the stability of the playing surface. Heavy shade also causes lower temperatures and problems of frost clearance.

Shade is not the only factor influenced by stadium design. Air movement is also considerably modified, especially where the ground is very enclosed. This has a number of consequences: evaporation and plant transpiration rates are reduced and the playing surface is generally wetter. Lack of air movement means that the relative humidity is greater and morning dew lasts longer. The cumulative effect of limited shade and limited air movement is to make the sward more susceptible to disease.

Management of shaded turf areas

Light panels are now widely used in the roofs of stadia to increase the transmission of light. Typically they are of transparent, UV-protected polycarbonate materials. It is important that they maintain their light transmission properties. The choice of material is important because some plastics can lose transparency and a cleaning contract is essential to reduce the effects of dust and any build-up of algae or moss.

In highly shaded stadia, some changes to the management regime may be required. This may include increased cutting height, reduced fertilizer application, reduced irrigation in shaded areas, and a tendency to apply water in the morning so that the leaf blades are not wet for long periods.

Complete turfing during the season is now carried out at several major United Kingdom stadia, and at others turf is replaced in high wear areas. Typically, 40 mm-thick turf is used, but careful consideration must be given to the growing medium in which the turf was produced and the species composition of the turf. The technology available for re-turfing has improved considerably in recent years.

CONCLUSION

The quality of playing surfaces in the United Kingdom has improved enormously in the last 20 years through greater understanding of management requirements, better construction methods, improved technology in terms of undersoil heating, better maintenance equipment, and improved grass cultivars. For large stadia used for professional sport, the main technical issue now affecting playing surface quality is almost certainly that of shade and the associated unfavorable microclimate and this is our greatest challenge over the next few years.