Even with the highest annual rainfall ever recorded, the failure in sports pitch drainage must give concern. Time and again assessments of poorly drained and muddy sites are made - the most common situation being the collection of surface water on pitches that are unable to promote any degree of surface drainage. Strange, after so much has been said and written on drainage installation techniques - particularly related to slit drains and grooving - standards of installation have reached new levels and current specialised equipment has become so efficient

Consultant, Gordon Jaaback, offers his views on the subject

Drainage is more than installing pipe and slit drains - understanding how surface water moves both on and below the surface is probably the most important consideration. Water lingering on the surface of heavy clay topsoiled pitches becomes a scourge to footballers. This water must be removed as soon as possible - at least before firm playing surfaces becomes soft muddy quagmires.

Rainfall becomes a vital consideration, and it is the intensity and duration that is most important. Wallingford research (FEH,1993) rates the occurrence of in the region of 25mm in one hour to be the maximum intensity expected over a ten year period in central and southern England.

It may be startling to some that over 80% of rainfall in the south is less than 10mm per day, with up to 50% being less than 2mm per day. Nevertheless, although average rainfall intensity in Britain is in the region of 5mm per hour, short duration heavy downpours in five to ten minutes can far exceed this rate falling at up to 100mm per hour. This is especially significant with the realization that rain can fall on average twelve days in the month during the winter season when, for much of the time, the surface soil is saturated and evapotranspiration is negligible (Jaaback,2008).

Impact of water moving over and above the soil surface (run-off)

Naturally, on commencement of rainfall, there is water retained in the turfgrass foliage, the micro-depressions within the soil surface and porous surfaces to drain installations. Estimates of the water retained have not been researched, but it is expected that they could amount to between 3mm and 5mm. What is certain is the fact that rainfall must exceed the retained amount before run-off commences (Tindell and Kunkel, 1999).

Secondly - and often overlooked - water run-off on to the pitch from higher ground always results in wetter areas. This flow must be diverted above the cut slope, if it exists. A practical measure to halt the movement of water over the soil surface is the installation of ditches and swales. The latter can become an integral means in attenuation (CIRIA,2000). In preventing run-off on to the pitch, shallow mowable swales at the base of cut slopes have proved very effective - particularly

Sports Pitch Drainage

Why are there still failures?

with pipe drainage installed in the invert of the swale.

Water does not move quickly laterally within the soil surface. On the surface, compaction, and the presence of organic matter and thatch, reduces infiltration significantly and, with persistent rain, saturation soon develops. Run-off is inevitable provided there is a suitable gradient over which to run. The degree of run-off after short sharp showers is underrated - yet it is always evident in depressions in a pitch, and has been significant in the swales down the sides of three cambered pitches without installed drainage over the last eighteen months.

What are the gradients necessary for satisfactory surface drainage of a sports pitch? Adams and Gibbs, 1994 are not specific, suggesting a diagonal fall between 1:67 and 1:100, but McIntyre, 1998 contends that a cross-gradient should not be flatter than 1:70. In cut-to-fill construction, gradients of 1:40 to 1:50 are well accepted and have been very effective. On level ground, the creation of a camber with side slopes of 1:70 is hardly noticeable and has also proved very successful. In fact, both Sport England and the Football Foundation do not state preferred gradients other than to say the maximum gradient across the line of play should not exceed 1:40 to 1:50.

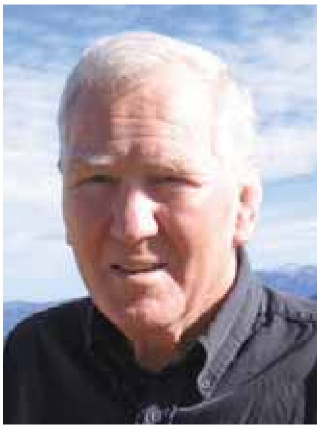
If a gradient is essential to move water laterally over the surface, and this water is to be removed as quickly as possible to retain firm topsoil conditions, then it goes without saying that close-spaced slit drains, intended to bypass the heavy relatively impermeable topsoil, should be as close as possible. Spacing of one metre appears to be most practical and suitable to retain firm conditions. What we do know, is that this method of bypassing the heavy clay soils does work, and soft muddy conditions can be prevented if this surface water is removed quickly in this manner.

Contrary to desired normal summer procedures of aerating with the vertidrain and earthquake, any loosening and opening up of the firm clay loam topsoil in the winter months can lead to disaster - surplus water enters and is collected in the upper layers, making them wetter and softer. At this time, firm surface conditions are vital to sustain play, and surplus water should be despatched quickly into the bypass system of slit drains or grooves.

Water moving below the soil surface

Infiltration rate is critical and so dependent on the condition of the soil matrix, the homogeneity of the particle size distribution and the organic matter content. At this point, it is worth mentioning the folly of ameliorating the upper rootzone by incorporating relatively small quantities of sand into heavy clay loam soils. Since the objective is to improve resistance to compaction and increase porosity, the particle size distribution of the sand is vital and there must be a dominance of sand in the resultant mixture (Waddington et al, 1974).

Where an improved rootzone is imported, it should be fully evaluated in laboratory tests. The depth is determined on assessment of the critical tension. There has been extensive research into the criterion in rootzone design. Awareness of the capillary fringe above a drainage carpet or slow draining base is essential in drainage design - particularly the fact that water is held in the fringe to almost saturation before being released into the lower layers or adjacent drainage (Adams, and Gibbs, 1994, McIntyre,



"Any loosening and opening up of the firm clay loam topsoil in the winter months can lead to disaster - surplus water enters and is collected in the upper layers, making them wetter and softer"

GLOSSARY

Drainage design rate - This is the rate at which drainage system installation removes water from a given site and the measurement is given in mm over the drained area.

Infiltration rate - This is the measurement on site of the rate at which water enters the soil surface

Double ring infiltrometer - Two steel concentric rings are knocked into the grass surface and both rings are filled with water to the topmost surface of the rings. The infiltration rate is measured by noting the time taken for the measured full depth of water to drop in inside ring once field capacity is reached or after 30minutes of initial infiltration.

Hydraulic conductivity (or the percolation rate) - This is the laboratory measurement of the movement of water downwards over a period of 24 hours through a saturated compacted soil sample subject to a negative tension of 30cm and under a permanent head of water.

Particle size distribution - This refers to the laboratory assessment of the proportional contents of clay, silt and the different sand fractions in the soil or aggregate.

Saturation - This condition in the soil is reached when all the voids are filled with water.

Field capacity - Once all the water in the soil that drains due to gravity alone is lost to lower layers and only water remaining is held by the soil particles, field capacity is reached.

Surface gradient - This describes the fall in elevation over the length, the width or both in the final grading of the sports pitch.

Porosity - This is a general measurement of the percentage of voids or spaces in the soil and comprises larger air-filled voids (non-capillary porosity) and smaller water-filled voids (capillary porosity). The relative proportion of both these voids determines the porosity.

Critical tension - This is the depth of a root zone material of specific particle size distribution needed to enable drainage downwards and the opening of pore spaces at the surface sufficient to support satisfactory growth.

Pore continuity - When the pore spaces between soil particles of a growing medium conform with the pore spaces of a material directly below it there can be downward movement of drainage water. A coarse material below a finer material does not have pore continuity and drainage water is withheld in the material above until saturation is reached.

Suspended water (capillary fringe) - This water is suspended in the rootzone in a saturated condition above the blinding layer or above a free water zone. This suspended water is not able to move to drains and its depth will depend on the particle size of the sand and the rate of free water removed sideways to drains or downwards into the base material. Where a finer material exists below the rootzone, this water will only move downwards as the base begins to drain.

Free water - This water collects at the bottom of a rootzone below the capillary fringe over a slowly draining base material or penetrates through a blinding layer after saturation in the rootzone is reached. Accumulating below suspended (or perched) water, this free water is not held with any force and it can move readily sideways to drains and downwards into a slowly draining base material.

Slit drains - These are narrower excavated drains without pipes and normally 50mm wide, backfilled with stone aggregate and topped with coarse sand to the surface. The depth is 250 to 300mm.

Sand injected grooves - These are narrow slit drains installed with vibrating rotating tines and simultaneously filled with a coarse sand/grit. The slits are 20mm wide, not more than 170mm deep and are installed at 260mm spacing.

Swales - These are constructed linear depressions to divert surface water flow. They are installed with suitable gradient and side slopes of around 1:8 - and with a depth of around 200mm are easily mowed. Preferably pipe drainage is installed in the invert of the swale.

Attenuation - Slowing down the rate of flow to prevent flooding and erosion, with consequent increase in the duration of flow.

"It is worth mentioning the folly of ameliorating the upper rootzone by incorporating relatively small quantities of sand into heavy clay loam soils"

1998). The nature and condition of the base (subsoil) are often overlooked and little is done, during construction, to create optimum transition between the subsoil and topsoil.

Generally, compacted subsoil adequately ripped contains a finer combination of soil particles than indigenous topsoil above it. In this instance, pore continuity is maintained and there will be downward movement of water without suspension in the capillary fringe.

On the matter of water flow in slit drains and grooves, there can be misunderstanding. With lateral piped drains, often installed in the steepest gradient in order to despatch drainage water to collector drains and on to the outfall, the installation of slit drains and grooves at right angles serves to check and collect the surface water, permitting nothing more than - in the words of Geoffrey Davison - 'seeping' of water towards the nearest lateral drain. This fact is hard to appreciate given the fact that surface water must be removed as quickly as possible. It is only at times of sustained heavy rain, when all pores are saturated in the slits and grooves, that water flow may be more rapid.

The ironic fact is that successfully slit drained or grooved pitches depend on

the speed with which surface water can be removed. Slits and grooves are only functional so long as entry access at the top of a mini-drain is maintained in an open condition, allowing the surface water to easily get away. This means it becomes imperative to regularly apply sand dressing to the playing surface (Adams and Gibbs, 1974).

In practice, at the cost of in the order of £3500 per pitch annually, this expenditure generally is out of reach for many schools, clubs and local authorities. This leads to an inevitable conclusion that no surface drainage system employing slit drains or grooves should be installed if regular sand dressings are not going to be undertaken.

A final comment - following the difficulties experienced, and the effort made in topping up slit drains in the first year of establishment, thoughts have been directed to reducing the spacing of lateral drains to three metres and cutting out the installation of slit drains.

Time will tell, but the removal of collecting slits at right angles to the laterals reduces the potential for removing surface water - particularly if the laterals are installed down the steepest slope, probably the cross-gradient. However, by installing the close-spaced laterals, and following with grooving at right angles, this alternative system has much merit.

Though grooving is narrower, being 20mm in width, the close spacing of 260mm apart makes this alternative a worthwhile consideration. On the downside, the effectiveness of these narrower slits under heavy wear, over time, is under question. Repeat treatments may well be needed within a few years.

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