How Soil Structure Helps Putting Green Drainage

By KENNETH WELTON

Putting green drainage is an old subject. It gains attention during wet years and then is forgotten through a cycle of dry years. The most recent wave of interest was touched off with the excessively wet spring of 1947. The more I study putting green drainage the more I am convinced that successful drainage of this kind is more of an art than a science. This is only natural when one considers the great variety of conditions encountered from green to green.

There are external variables such as location, size, slope and grade and internal variables of soil type, including texture and structure, depth of top soil, and sub grade of the fill. If we had drainage data on a particular soil type, even then we would not be much ahead since the structure changes with treatment.

A change in structure can make the soil's reaction to moisture and air percolation greater than between two different soils. For example, I was recently shown a mid-west soil used for cash grain farming. I saw the same soil under different soil management conditions. In one case it weighed 66 lbs. per cu. ft., in another it weighed 82 lbs. per cu. ft. In the latter case the soil structure had broken down and it was hard and packed. The reduction in pore space was so reduced as to make this significant difference in density. One can readily see that within the same soil an entirely different set of drainage conditions may exist.

There are several other variables I might mention but I believe I have made a point that it is difficult to get exact data for each problem, and that if exact data was available on some of the variables we still could not use it without making allowances for the others.

But let's not complicate this subject. Actually a putting green is a comparatively small area and can be modified without too much cost and confusion. The important thing is to plan for good drainage in a new green and to diagnose the problem accurately for putting-green maintenance or before major alterations are undertaken. In other words, there are a variety of angles to putting-green drainage and if all of these are considered one has a good chance of solving the problems as they occur.

The first consideration is that plants are growing under extreme conditions. If the bent grass grew normally, it might grow a foot or more high and then its roots might reach almost that deep into the soil. But the plants are mowed to less than a half an inch in height. Grass cut so close cannot support a very deep root system. Most of the roots are concentrated within four inches of the surface. So, there is a very small reservoir of water. The roots can only come in contact with what water is available in that shallow depth of soil. That means frequent watering at certain times to maintain the supply.

Surface Drainage Important

Surface water must be disposed of, first, because the players will insist on getting on with their game the minute the rain stops and they don't like pools on the greens. But, more important, surface water must be disposed of before it weakens or drowns the plants. The time it takes to injure the plants depends on the conditions. For example, if the green is heavily fertilized and the weather is suitable for heavy growth, the grass will be using reserve nutrients and also oxygen to the limit of its capacity. A sudden shut-off of the oxygen supply might suffocate it in a few hours. On the other hand, grass growing under more natural conditions might survive several days of flooding. The air that the plant takes in through the leaves is not transported to the roots. The roots have to get their oxygen from the soil. There is a tremendous amount of energy used by the roots in pushing through the soil and transporting liquids and fertilizers up into the green part of the plant. A man uses a tremendous amount of oxygen as he works; so do the roots. There must be oxygen at the root zone

or the plant will suffocate. When water fills the pore spaces in the soil the oxygen is crowded out.

Also, most putting surfaces will be ruined if trampled while soggy. The depressions left by players' heels will remain on some soils and leave a bumpy surface, and this will be especially true if the nap on the turf is kept down, which should be done for best putting conditions. But, since players cannot always be kept off wet greens, the answer to a true putting surface is more dependent

Tile was laid in the sub soil of this new green before the top soil in background was applied.

on proper soil structure and good internal drainage. I will come to that later.

There are also other reasons for adequate surface drainage and one is disease. If there is a saturated condition near the surface, there will be high humidity close to the grass and in hot weather the conditions will be optimum for the growth of fungi and other disease causing organisms. So, water must be removed from the surface quickly. Then, in the winter if the surface soil is saturated and there is a heavy freeze, there will be heaving that will break the fibrous roots. If a warm spell follows and the grass starts growing it will not have the roots to support the growth and it will die. Each green therefore, should be designed so that water will flow off the surface if it can't get down to the sub-soil due to some extreme condition.

Get Good Sub-drainage

Sub-drainage is much more important than surface drainage. I don't want to see any water standing on a green, but with good sub-drainage the chances are that one will seldom have trouble from surface water. By sub-drainage I mean draining the water through or from the soil. And, the water doesn't have to be drained from the green to a depth of four or five feet, either. In building a golf green the contractor usually uses the material closest at hand for fill. If he uses sand, there will be no drainage problem. Ordinarily the contractor uses the silt or clay soils available from digging the traps, or from some waste area to make the fill for the greens. If this fill ever was of a permeable nature, the permeability will probably be destroyed before the contractor is through with it because it's moved, leveled and rolled with the equipment. The important thing is to finish the fill with sufficient grade that the water which percolates through the open top soil will gradually drain off to the sides of the green along the top of this sub-grade. To get this type of sub-drainage there should be a slope of, say three to four percent, on the surface of the fill although the grade on the putting surface of the green will probably never be more than three percent except at the edges.

There are many comparatively small greens on well designed courses. It's stupid to build a green with eight to ten thousand square feet of surface on a hole that is designed for a short iron approach. On such an approach, accuracy is called for, hence a small green is adequate. On these small greens of, say, five or six thousand square feet in area or less, the chances are little, if any, tile will be needed. The surface and sub-grade drainage should take care of it. But, if the green must be protected from surface water, which is often the case with greens fitted into hillsides, a shallow swail running around back of the green should be provided which will direct the surface water around the green to the side. Also, there will be cases where water seeping from higher elevations comes to the surface. In such cases a trench deep enough to catch this seepage should be dug and tiled. The back fill should be made with cinders or gravel up to a foot of the surface.

Why Tile Drainage

For larger greens with impervious fill, there is little doubt that a system of tile drainage should be provided; but my experience leads me to believe that there's been too much tile slapped in without very much thought of why. There's been more talk about whether you use a her-

ringbone or a gridiron design in laying the tile than there has been on why and where the tile is needed. If you've got a big green with a good sub-grade, the higher portions at the back of the green will be well enough drained without tile. Catch all the isolated low spots and use the majority of the tile on the lower half. Lay the tile to protect the approach from seepage. A soft, soggy approach is bad both for the player and for the turf.

And now, I want to devote some time to soil structure. The whole subject of putting-green drainage is pretty well tied in with soil structure. The structure of the soil refers to the arrangement of the soil particles in relation to the voids or spaces between the particles. In some soils the particles cling together and form odd shaped crumbs or granules. These do not fit tightly and hence there is a correspondingly large area of space for air and also for entry and percolation of water. On the other hand, the particles in some soils do not form crumbs or granules; the particles fit tightly together in a solid mass with a corresponding loss in pore space. These soils are more dense and have higher specific gravity than soils with porous structure. A soil of a friable or porous nature is needed to maintain healthy turf. The structure of the surface soil also has a considerable effect on the playability of the green. A soil that puddles and packs when wet will dry into a solid brick-like mass. A ball pitched to the green bounces and runs as if on a path. It will not hold the green. So the players kick and then the green must be watered to soften it. You can see that between the original lack of pore space in such a soil, even when dry, plus the super saturated condition it must be kept in to keep it from hardening, the grass has little chance and soon becomes thin and dies.

Right Soil Structure

A soil may be of good structure under natural conditions but when it is spread on the surface of a putting green it is subjected to trampling and its structure may quickly be destroyed by puddling caused by the trampling of players on the green while it is wet. An ideal soil is one that will keep open and porous even under such adverse conditions. Of course, a sandy soil will stand trampling and remain porous because there is little or no clay and silt in it to cement the particles together. But, pure sand will not hold moisture and plant food for long; it dries out too quickly. Our problem is, therefore, to get a loamy soil, one with enough silt and clay, but one which will not puddle and become dense. Organic matter, such as peat, is very porous and will not puddle and cement together. It is like sand in this connection. Add enough peat and sand to a loamy soil to hold the silt and clay particles apart to obtain the best structure.

It is best to test soils before using them as top soil on a green. If a soil when damp may be rolled into a marble which will hold its shape when tossed in the air and caught, or if it can be molded into the form of a worm when rolled between the hands, it is too plastic or putty-like. Add other materials to it to bring it to the correct composition.

Organic matter is effective in break-

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Drainage of traps around this new green (right rear) is being taken care of by tying them into the main tile system.

Hempstead, Mrs. George H. Bostwick of Meadow Brook, Mrs. Al Baar of Fresh Meadow, Mrs. Arthur K. Atkinson of Creen and Mrs. Lucy Armstrong of Creek.

While strolling out of Garden City Hotel, Frank Strafaci, five-time Metropolitan amateur champion and one of the great shotmakers of the country, remarked, "Golf is doing something really worth while in these parts and I would like to see golfers in other parts of the country take time out to remember a lot of kids were wounded and would like to putt or pitch at rehabilitation centers as they strive to regain health."

That was the sentiment of a lad who did a lot of island hopping in the Pacific with General Douglas Mac Arthur during the late war. A lot of his buddies were wounded and as Frank says "we can't do too much for them."

HOW SOIL STRUCTURE HELPS

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ing down the plasticity of a soil. But if there is too high a percentage of organic matter the soil will be spongy and it will be impossible to maintain a true firm putting surface. Also, although peats will take a lot of water, they will likewise hold water in the cells which the grass roots can't get, in which case even though the peaty soil seems moist the grass may wilt for lack of moisture. Too much organic matter in our putting green soils, therefore, is not good.

Test Soils and Mixtures

Here is a good way to test soils and soil mixtures, both for building the surface on a green and as a mixture for top dressing. Use the soil that you have available as the base or bulk of all mixtures you will make. Possibly you have a bed you're cultivating to get rid of weeds. Sift this soil and then set aside one sample of the pure soil. Then to another sifted sample add about 1/8 by volume of good sedge, reed, or woody peat. German moss peat isn't fine enough unless you can grind it up some way. To another sample of soil add 1/8 of peat and 1/8 of coarse, clean sand. To another one add 1/8 peat and 1/4 of sand and to another one 1/4 of peat and 1/4 of sand. That's five samples. If you need any further, leave the peat at 1/4 and increase the sand.

Each sample should be 2 or 3 quarts in volume.

Put a sample in the bottom of a bucket, pour water in, stirring it until you get it to a consistency just short of where it will pour. A more exact check is to thin it to the point where you can draw your finger through the top of the mud and that impression will still remain there until you tap the pail on the floor two or three times, when the surface will slick over again. Towards the end add water sparingly because the consistency will change very quickly. Do the same with each mixture and trowel each sample into a cigar box or some other container of at least 1 1/4 inches in depth. Make a record of the mixture in each sample and leave them for four or five days on the rafters or someplace in your shop where it is pretty dry and where they will dry uniformly. After the samples are dry, test them. You will probably find the pure soil, and perhaps one or more of the other mixtures, has dried so hard that you can't crush or crumble it in your hand.

In order to have some uniformity in testing the force it takes to crumble them use the same method on each. My experience in testing hundreds of samples has proven to my satisfaction that when you can't crumble a sample of 1 1/4 inches in thickness between the thumb and fingers of one hand, the mixture is too plastic for a green. So, test each dried sample in that manner and if you can break the sample of pure soil it's an exception, and you can use it. But, if not, continue from the mixture with the least peat and sand added, to the ones with more added, until you get one that crumples as described, and that's a safe mixture.

Avoid Soil Layers

Remember, you cannot correct poor soil structure by putting on a layer of this and that, because layers stop capillary movement of water and the roots simply come down to the layer and stop. You can demonstrate that easily by putting, say, 6" of a sifted silt or clay soil in the bottom of a tube and then add a little sand or peat, say 1/4" thick, and put some more soil on top of that; then stand the tube in a jar of water. After a few hours the water will come right up to the sand or peat and stop there. Of course, if you have the layer too close to the water, the water will force its way

through, but if the layer is near the upper limit of capillary attraction, as it would frequently be in a green, the water will stop at the layer. In a green the roots will just go down to that dry layer and stop. So, you get into a lot of trouble with layering from shallow root systems. You can't go to extremes in nature; use a mixture.

Now, to go back to tile again, most greenkeepers want to know the depth, size and spacing of tile in putting greens. I like a 4" tile. A lot of 5" and 6" tile are now being made. Five inch tile is OK, but 6" provides a larger drainage way than necessary. As to the depth and the spacing, that's where everyone does not agree with me. I like to keep the water table as high as possible in the green to get the greatest possible supply of capillary water. Some say that capillary moisture is relatively unimportant as a moisture supply in a putting green. However, since the major supply of water the turf uses is capillary water (the moisture that clings as a thin layer to the soil particles) rather than free water, I sus-

pect these people do not mean exactly what they say. In other words, if the grass does not depend upon capillary water, then it must depend upon the only other type available which is free or gravitational water.

Provide Capillary Water Supply

It is free water that fills the pore spaces of the soil and excludes air, and this is the kind that must be drained off. It is the capillary water we are most interested in. I expect what those who depreciate the importance of capillary moisture really mean, is that it is impossible to maintain an adequate supply of capillary moisture without frequent watering. That is true on too many putting greens. But, frequent watering is costly and always results in temporary, at least, saturation of the surface which presents certain problems while it lasts. I feel it would be a move in the right direction if every greenkeeper would work towards maintaining as great a supply of capillary water from the water table as possible and thus cut down watering.

To provide a greater supply of capillary water it is necessary to hold the top of the free water table as close to the surface as is consistent with good turf needs. The maximum use of the free water stored below cannot be obtained if tile is laid too deeply because the water level is held below the efficient range of capillary movement. As far as I know, the highway engineers have done the most work on capillary movement of water in soils. Their researchers show that the further one gets away from a reservoir the slower the movement. Water will rise in peats 5 1/2" in one day through capillary attraction. In sands, water will rise 11 1/2" in a day. As the soil particles get finer, the water rises higher. In silt loams it will rise about 20" in a day and in some clays it will rise even higher.

These are the possibilities in three components of the proper top soils I have been discussing—peat, sand and silt or clay loam. When a mixture of these three exists, one may expect the maximum supply of capillary water within 5 1/2 – 20" from the top of the water table, which is controlled by the depth of the tile. Since turf roots do not go much deeper than 6", theoretically, the water table can be held that high; but that is hardly practical. Lay the tile about 18" deep. This should provide a maximum of capillary water—and it is not so shallow that super

dry areas will appear on the surface above the tile.

The spacing may be fairly close if necessary — even 10 to 12 feet apart. It won't make any great difference because the idea is to get the free water out. Drainage will not draw off the capillary water. Some like to put an inch of cinders or gravel in the bottom of the trench in which the tile is layed. It does facilitate laying of tile because the tile can be moved around to a true grade quickly. Some also like to cover the tile around the sides and over the top with cinders or gravel in order to keep the loose soil from running into the tile through the joints, and that's all right. But, the cinders should not be carried to within less than about a foot of the surface. Back fill the trench with the prepared surface soil.

In conclusion, let me add that I have tried to show that the drainage of a particular putting green is not an exact science; it is more of an art. Perfection in drainage does not depend upon engineering alone but also on soil physics, plant physiology, horticulture and agronomy. Greenkeepers know their turf problems better than any one else. Study each situation, and don't underestimate the importance of proper soil structure in the putting green.

HOW MUCH "MIND-READING"

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get into the member's mind. These pros do all right by themselves by thinking of their players first. They quickly catalog their members and know what elements must be emphasized to appeal to the individual. One member may be shy, another may be show-offy, another have a driving ambition to win something, another just out to have some fun, another belonging to the club because his family wants club membership, another may be rich and tight, another may want to buy everything he can sign for but have a hell of a time paying, one may be a good fellow and another may be a complaining sour-puss who is one of the admission committee's mistakes. The pro has to be all things to all men, and — to all women who are active in the club's golf the pro's adaptability and finesse must be even greater than with the men.

Humans Are Simple

But golfers aren't so complex that they represent an unfathomable problem to the pro who thinks of them individually. That