Golf Course Drainage

A series of articles written exclusively for THE NATIONAL GREENKEEPER by America's foremost golf course drainage engineer

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Part V—Rate of Run-Off and Sizes of Tile

THE following discussion of runoff and the methods of calculating sizes of tile is of particular value to the greenkeeper in explaining how his system should be designed and by furnishing him with a means of understanding the decision of the engineer upon questions which may arise regarding the sizes of tile to be used.

The portion of the rainfall or snowfall which passes over or through the ground to the natural or artificial drainage channels is termed runoff. It is that part which passes through the soil to the drains which is of particular interest in this discussion.

The rate of runoff is variously expressed as a percentage of the rainfall, as the depth in inches removed from the watershed per 24 hours, and as cubic feet per second, or per 24 hours, from each unit of watershed area.

It is probable that the method most common in present day drainage practice is to express the rate of runoff as the depth in inches removed from the watershed in 24 hours. This depth is often referred to as the runoff coefficient or the drainage coefficieint, or in the abbreviated form of a "3/8 inch runoff." This method of expressing the rate of runoff will be used in this discussion.

The runoff coefficient adopted will control a large measure of the cost and the efficiency of the operation. It should provide a rate of runoff large enough to insure adequate drainage for heaviest storms to be expected year after year, though perhaps it is not always necessary to provide sufficient capacity for the extreme maximum during those extraordinary storms which occur, say, once in ten or fifteen years.

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Runoff From Underdrains

THE rate of runoff from underdrains will vary directly, though not necessarily proportionally, with the amount and character of the rainfall. Localities subject to heavy rainfalls will have a rate of runoff larger than will other localities having less rainfall. The nature of the storms also, will have a marked effect upon the runoff from underdrains. For instance, a rain of one inch falling in a short time, as in summer thundershowers, will cause a much smaller total runoff from underdrains than one of an equal amount falling as a gentle rain for twelve or twenty-four hours. In the case of the heavy shower the water reaches the earth much faster than it can be taken up by the soil, and, of necessity much of it must run away over the surface. However, the rainfall in the Central States is of sufficient uniformity that so far as this factor is concerned, the runoff coefficient will be the same for all portions of the state.

The rate of runoff is markedly affected by the size, shape and slope of the watershed or drainage area. Other things being equal, the rate of runoff from a large area is somewhat smaller per acre than it is from a small one, and that from a long, narrow watershed is somewhat less per acre than from one nearly circular. However, the size and slope of the watershed affects the rate of surface runoff more than they do the runoff through underdrains. As a matter of fact, the rate at which the water moves through the drains is so much greater than that at which it moves through the soil to the drain, that the effect of these factors is comparatively small.

In deciding upon the runoff coefficient, the relation of the size, shape and slopes of the untiled contributary watershed must be considered in connection with the area actually to be underdrained. If the untiled adjacent area is comparatively large and has fairly steep slopes, the surface and underground runoffs on to the flatter tiled area below are equivalent to so much additional rainfall, and must be taken into account in designing the drainage system for the flatter area.

Character of Soil Affects Runoff

THE rate of runoff is considerably affected by the character of the soil. In close soils, such as clay, the water will not pass down to the drains as rapidly as it will in a more open soil such as loam. It is for this reason that tile in clay soils are laid with relatively close spacing, and generally should be kept at the top of any very impervious subsoil stratum.

The rate of runoff will vary with the seasons. A rain of a given character and amount in the early spring will cause a much larger rate of runoff than if it occurred in July or August. During the warm months, when the natural evaporation from the ground surface is large, and when the crops are growing rapidly and drawing large amounts of water from the soil, the groundwater is maintained at a comparatively low level, thus creating a large storage reservoir in the soil. Under these conditions the soil absorbs and holds what water is necessary for plant life, and accordingly decreases the rate of runoff through the drains.

In golf course work throughout the Central States a common practice has been to use a runoff coefficient which will provide for the removal of a ¼ to ½ inch depth of water from the drainage area in 24 hours, though of late, there is a tendency among drainage engineers to provide for larger capacities in some instances. No one coefficient is truly applicable to all drainage systems in the state. This low value may be correct under some conditions, but is probably smaller than should be used for a great many systems. So if an average value is to be stated, it seems probable that ⅜ inch will be more satisfactory than ¼ inch. In realty the maximum rate of actual underdrainage runoff will vary, under different conditions, from ¼ inch to more than ½ inch. All the factors affecting the rate of runoff must be considered in deciding upon the correct value.

If the rate of runoff is equal to the removal of ¼ inch depth of water per 24 hours, the flow will be 0.0105 cubic feet per second from each acre. The total flow from 100 acres would thus be 100 times 0.0105 or 1.05 cubic feet per second. When the rate of runoff is 5/16 inch, ⅜ inch or ½ inch, the rate of flow in cubic feet per second, from each acre will be 1¼, 1½ or 2 times 0.0105' respectively.

How to Select Tile

THE actual determination of the proper size of tile to be used in any particular location should be left to the engineer who designs the system.

Clay Tile: A large part of the tile that has been laid on golf courses is made of burnt clay. This general use is due largely to the common occurrence of clay adapted to tile manufacturing. The porosity of clay tile is not an advantage because the water enters through the crack between the tile. The high water content of the walls is a distinct disadvantage where tile are subjected to sudden freezing and thawing many times during the winter. The sudden expansion and contracting of the water held in the walls may cause the tile to crumble in a single winter.

Shale Tile: Shale tile resemble clay tile but have a more glossy surface. They are also less porous and harder than clay tile. They are made of ground shale rock, wet and mixed until it is plastic. The walls of shale tile hold so little water that they are not injured by repeated sudden freezing and thawing. If the tile are to be subjected to unusual abuse the slight extra cost of shale tile is a wise insurance against possible loss.

Vitrified Tile: Vitrified tile are harder and more glossy than even shale tile. They are used commonly for sewers. Their only disadvantage is that they cost more than clay tile of the same size. Where the fall is more than 1 foot in 100 feet in a main tile, water flows with such force that it may wash ordinary tile out of place while vitrified tile stay in place. The collar or bell on the larger vitrified tile make it possible to cement them together. This stiffens the line so that it endures the violence of the rushing water. Two or three lengths of vitrified tile cemented together are desirable at the outlet of every main line of tile. Such an outlet bears undermining and exposure without injury.

Tile To Be Rejected

A LINE of tile is no better than its poorest tile. The man laying the tile is in position to cull out the poorer ones and to lay only the good ones. Nevertheless the shipment as a whole should be examined before the tile are taken from the freight yard. Reject the entire lot if 5 per cent appear to have been below standard upon leaving the factory. Excessive breakage due apparently to inferior quality is also cause for wholesale rejection. If the breakage is due to rough handling, accept the unbroken tile but reject the broken one. Let the shipper settle with the railroad company, but notify the railroad agent of the breakage at once.

Clay tile whose weight can be increased more than 14 per cent by absorbed water are too porous. Twelve per cent is the maximum limit of permissible absorption for cement tile. The less the absorption capacity the better the tile endure repeated freezing.

Tile that cannot bear the weight of 800 pounds of linear foot without crushing are below established standards. A 4-inch tile requires this strength as an indication of quality. The larger tile require strength because of the weight of earth that they must actually bear. A 16-inch tile under 10 feet of wet clay must bear a weight of about 2,000 pounds a linear foot.

Tile that are cracked may be detected by a dead sound when struck with a light hammer. They are unsafe. Somewhat objectionable, but more permissible are tile with notched ends. Where these notches are more than one-fourth inch deep, patches or bats made of pieces of broken tile are necessary. Tile of good material but patched or warped are less objectionable in a clay or a peat soil than in a sand. Tile of poor material are to be avoided in any soil.
