Golf Course Irrigation

A Top Designer and Engineer of Watering Systems Discusses Turf Needs, Pipe Distribution

(First of three articles)

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THERE probably is nothing more frustrating than poor sprinkler performance. It nearly always is due to a lack of water and pressure, mainly caused by a poorly designed system of distribution piping.

Probably the first thing to determine in the design of any irrigation system is maximum turf water requirements, and then plan accordingly. An efficient system should be of such a size as will provide maximum precipitation regardless of expected rainfall.

The average 18-hole course has approximately 45 acres of mown fairway area and 5 acres of tees and greens which must be watered. If we plan on precipitating 1 in. of water per week over this area it will require 50 x 27,154 – or 1,357,700 gals. This amount, in a six-day working week, breaks down to 226,283 gals. per day. In an 8-hour day it works out to approximately 500 gpm.

One method in fairway watering which has given satisfactory results has been to zone the fairways into three areas of six fairways per area and plan on watering these in one night. Thus, the course can be watered twice weekly. When ½ in. of water is applied to the fairway area at each watering the desired one in. of water is precipitated weekly. But with bent fairways becoming more popular there is some doubt if they can go for three days without water in the hot part of the summer.

Although there is no standard width for a fairway, 150 feet or 50 yards is accepted as fairly representative. In order to water a fairway of this width from the middle, it is necessary to have the sprinkler cover a diameter of 180 feet. This means that some of the water spills into the rough, but as the best of sprinklers only provide even watering for the first 80 per cent of coverage, the outer 20 per cent tapers off from full coverage to a few drops on the outer edge, water falling onto the rough is very small.

Recommends 85-ft. Intervals.

It is common practice to locate sprinkler valves down the middle of the fairway at 90 or 85 ft. intervals. I have found the 85 ft. interval spacing to be economical. Mills turn out 3-in. pipe in exact 21 ft. lengths and four such lengths plus fittings equal 85 ft. Thus a great deal of threading and cutting is eliminated for in any course system it will be found that 3-in. pipe represents about one-third of total pipe footage used.

At a pressure of 90 psi at the base of the sprinkler the average fairway sprinkler, to cover 180 ft. in dia. discharges 60 gpm. When a total of 500 gpm is provided at the pump it will be noted that eight of these large sprinklers may be used.

In order to operate them economically and thereby keep pipe sizes to a minimum, they should be initially distributed over the six fairways selected for watering in a single night. This, in turn, distributes the water load in the piping system. As one hour of sprinkler operation in any one location usually provides sufficient precipitation, sprinklers are moved to each of the next fairway valves each hour. This schedule is maintained until each of the fairways is watered. It seems to work out that it takes the full time of one man to handle eight sprinklers per hour.

If we attempted to water an entire fairway at one time, it would require that almost all sprinklers be located on that fairway. This, in turn, would entail large sized piping all over the course and would greatly increase the cost of the irrigation system.

When the schedule and routing of sprinklers are determined, it becomes a rather easy matter to arrive at the maximum flow of water to the various parts of the course. This permits correct selection

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This, and articles that will follow, are a condensation of a speech made by Stewart at a Midwest GCSA conference.

of pipe sizes and eliminates guessing.

When water flows through a pipe it always sets up some loss by its rubbing effect on the internal walls of the pipe. This is called friction loss. The faster water moves, the greater is the friction loss. The problem that faces the design engineer is to determine how much friction loss is allowable, for the smaller the pipe the greater is the friction loss and vice versa.

One approach to this problem might be to base the size of the pipe, once the flow is known, on the yearly use of the piping system. In the Midwest the average watering season on a golf course is 120 days. But during this time we can expect 20 of these days will bring rain or climatic conditions when watering will not be required. (A study of rainfall, humidity and temperature records for a 20-year period in the Chicago area has revealed this condition,). Consequently, our watering time may be taken as 100 days per year. Courses in California, Florida and other southern states have a much longer watering time.

In view of the comparatively short use of irrigation systems each year, Midwest courses can put up with greater pipe friction loss (i.e. smaller pipe) than those in the south or California.

The aim of the design engineer is, of course, to try and strike a balance between the yearly loss in efficiency by using a somewhat smaller pipe, and the savings in the initial cost of the system. This may be done by selecting two or three sizes of pipe for a given water flow. Then by analyzing the initial cost for each size of pipe, yearly interest on the amount invested, annual maintenance cost, life expectancy of the pipe and the yearly friction loss of the water flowing through the pipe expressed in kilowatt hours and then reduced to a dollar and cents amount, the most economical size of pipe will be determined.

This is a cumbersome procedure, but by using it for many sizes of pipe and for many different flows of water, it seems to work out that a much faster method in selecting the correct size of pipe is to try and limit the speed, or velocity, of the water flowing through the pipe to 5 ft. per sec. This is arrived at when we realize that the pipe velocity formula is

$$\frac{\textbf{Gals. per minute x 0.404}}{\textbf{D squared}}$$

D being inside dia. of the pipe in inches.

Many pump, pipe and sprinkler manufacturers give excellent tables in their catalogs which show pipe friction loss and velocity in ft. per sec. for various pipe sizes and flows.

Comparison of Pipe Diameters

It is frequently desired to know what number of pipes of a given size are equal in carrying capacity to one pipe of a larger size. At the same velocity of flow, volume delivered by two pipes of different sizes is proportional to the squares of their diameters. Thus one 4 in. pipe will deliver the same volume as four 2 in. pipes. With the same pressure at the entry point, velocity of the water is less in the smaller pipes and the volume delivered varies about as the square root of the fifth power. Consequently, when we double the size of any pipe line we actually increase its delivery by 5.7 times (one 4-in. pipe will deliver as much water as 5.7 2-in. pipes).

This same formula reveals that one 3-in. pipe delivers as much water, even slightly more, than a 2½-in. pipe plus a 2-in. pipe. I am sure many of you have seen courses where hundreds of feet of 2½-in. pipe was used. How much more efficient the system would have been if 3-in. pipe had been used. It costs as much to install 2½-in. pipe as 3-in. Further, 3-in. pipe is only about 20 percent more in cost than 2½-in. pipe.

It is believed by some that if the piping is not "looped" the system is of little value. My experience indicates that this is not always true. The idea of looping a piping system comes from the practice employed by city engineers. They find it necessary to use this form of piping design for many reasons, one being that domestic water must be circulated; another that they never know the peak water load that might be required at any part of the city. For instance, a number of fires could break out in one part of a city where large quantities of water would be needed. One way to get a large quantity of water is to have it flow from many points in the looped piping system to the desired location.

Plans for Maximum Demand

Fortunately, the golf irrigation engineer is not faced with a condition where there will be large and unknown water demands. Consequently, he does not have to employ a costly system of looped piping. If he plans the system for maximum demand in the first place he can arrive at

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the peak water load at any point on the golf course and size the pipes accordingly. Although it is relatively easy to compute water flow in most looped designs and find out the proportion of the water being carried by the various pipes in the loop to one central point, I am sure many of you have seen irrigation designs with so many loops that it is doubtful if Prof. Einstein himself could have made exact hydraulic computations.

In my own work in the design of over 300 course irrigation systems, I have only found it advantageous to use a looped design in about 10 per cent of the projects. The balance was prepared on a "dead-ended" piping design.

Looping a piping system is not wholly wrong, but often it is not necessary. If the amount of money put into the hundreds of extra ft. of pipe, often used in a looped system, were put into one pipe of a larger size it often would be found that the larger pipe provides much more water than the looped system of smaller piping. The thought held by some that a looped system of piping provides constant water pressures is not entirely true. The further we get out on any looped piping system the greater is the pipe friction loss. This, in turn, creates a drop in pressure.

Course layout determines irrigation design. Far-flung courses with great distances between fairways are often best suited for a looped system while groups of parallel fairways rather close to each other are certainly more economically designed for the dead-end system. I have in mind two courses on Long Island, N. Y., one being the Queens Valley CC which has a major looped system and its neighbor, Fresh Meadow CC which has no loops whatsoever. No difference in a practical way can be seen in the results and operation of either system.

13th Jaycee Tournament to be Played in Tucson, Aug. 18-23

National finals of the 13th International Jaycee Golf championship will be played at El Rio CC, Tucson, Ariz., Aug. 18-23. Approximately 200 players under 18 years of age from the 48 states and Hawaii are expected to qualify for the finals. Past Jaycee tourneys have produced a large number of winners, runner-ups or strong contenders who later turned pro or became top amateurs. They include Al Mengert, Gene Littler, Bud Holscher, Doug Sanders, Tommy Jacobs, Phil Rodgers, Allen Geiberger and Jack Nicklaus.

Sponsors besides the Jaycee organization include the Bottlers of Coca Cola, Athletic Institute and National Golf Fdn.