Designing Irrigation Systems for Golf Courses

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In this first paper of the day, an attempt will be made to discuss some general aspects of golf course irrigation systems. Many points will be elaborated on in papers to follow.

While no attempt will be made to offer a short course in irrigation design, we shall dwell briefly on some of the fundamentals of sprinkler performance and principles of design. It is assumed that presently all adequate and proper golf course irrigation is accomplished with sprinkler irrigation.

SPRINKLER SPACING AND PATTERNS

Some principles to be discussed are familiar to many of you, but it may be advantageous to review them briefly. All the practical and efficient sprinkler systems available today are rotating nozzle type, applying water in a circular pattern. That is not a very profound observation, but nevertheless, a very important factor to remember when analyzing and selecting sprinkler patterns and their placement in a design.

A triangular pattern of sprinkler placement has proved to be the most efficient arrangement to produce uniform rates of application. Uniform rates of application plus adequate coverage are two of the prime requisites of all good irrigation systems. Considering the geometry of a circle, one will perceive that as the distance away from a sprinkler increases, the area increases very rapidly (by a factor of the square of the distance), so that the amount of water being applied per unit of area is decreasing rapidly. This fact necessitates using an arrangement of overlapping patterns so that adequate and equal amounts of water are applied to all areas during the sprinkling period. Acceptable maximum spacing for turf application demands that when sprinklers are located in a triangular arrangement, the distance between locations should be equal to approximately 67% of the diameter of the discharge pattern.

It is obvious that the area close to each sprinkler receives water from that sprinkler only, and that along a line running directly from one sprinkler to the next, as one coverage is decreasing the other is aiding until at a point one half the distance between the two sprinklers each is applying half the necessary amount. Furthermore, at a point the greatest distance from all sprinklers within the triangular pattern it requires the combined application of three sprinklers to result in an evenrate of application.

Thus we see the desirability of sprinklers being spaced in such a way that each one assists the adjacent ones in providing uniform application.

At the edge of an irrigated area such as a fairway there is not an adjacent row of sprinklers to assist, we find a scalloped area between adequate and inadequate moisture where the necessary additional application of water is missing. This should emphasize the fact that in

the case of sprinklers located in fairways only, and not in the adjacent roughs, that the line of sprinklers must be located very close to the edge of the fairway to provide adequate coverage of the full fairway width, with very little effective watering in the roughs.

SPRINKLER UNIFORMITY

Should one consider spacing of sprinklers based only upon a percentage of diameter, and should he design accordingly, he could get into trouble. The assumption is that the result will be a uniform distribution of water.

Sprinklers with similar diameters may not necessarily produce similar precipitation patterns. Therefore, one may use two sprinklers with the same performance rating but find that the degree of uniformity in a given spacing arrangement is quite different. One may be acceptable while the other is completely unsatisfactory.

PRECIPITATION RATE

Another very important aspect of design is the precipitation rate that results from the spacing used for the specific sprinkler installed. The agronomists and soils specialists can tell us a lot about what this maximum rate should be. There are too many factors affecting this determination to be examined in detail in the scope of this discussion.

However, it has been found that with well-maintained turf, on reasonably permeable soil, an average rate of 1/3 of an inch per hour is acceptable. Rates that exceed this amount can result in run-off and ponding. Please note that the unit of definition we use is based on the amount applied if the sprinklers run the entire 60 minutes of the hour. The total amount of water applied during a given period may be considerably less even at a higher precipitation rate if the sprinklers are operated only for a very short duration of time.

For example, one designer asserted that he was applying water at a rate of 6/100 of an inch an hour and that the sprinklers discharge 36 GPM spaced 90 feet apart. In this case the rate was actually ½ of an inch per hour, but the sprinklers were operated for only 7½ minutes each hour. Inasmuch as this period approximates .12 hours, the ½ inch per hour rate will yield 6/100 inches of actual precipitation per hour. Obviously we must define our terms to describe properly and evaluate any circumstance.

SPRINKLER SIZING

Rotary pop-up sprinklers of variable output and effective diameter are available. With a given spacing, increased size of sprinklers increases the precipitation rate. Individual sprinkler coverage exceeding 80 to 85 feet in diameter demands a sprinkler with too high a precipitation rate for the satisfactory irrigation of golf course turf. Recent studies indicate that the smaller the droplet size the better penetration through the turf and thatch to reach the soil and therefore more efficient turf irrigation.

The principles of physics indicate that large droplets can be thrown much farther from a sprinkler than can small droplets. Necessarily then, large diameter patterns depend upon the maintaining of large droplet size. It is strongly recommended that only short to medium range sprinklers be used and that spacings be limited to a *maximum* of approximately 80 feet for golf course turf irrigation.

If one studies a sketch of a single-

All seems confusion at The Creek Club, Locust Valley N. Y., as workmen prepare to lay sod. In the second photograph the soil is pounded into place with a vibrating tamper. All is neat and trim again in the final picture. The soil is level with the adjacent fairway and the sod is back in place. No depression!

row down-the-middle arrangement of fairway sprinklers, he may observe that even with speed control for the overlapped and non-overlapped areas, the pattern of distribution is not satisfactory. The precipitation rate close to the sprinkler is far too high and the droplet size required to reach halfway across a wide fairway is much too large for satisfactory results.

OTHER DESIGN CONSIDERATIONS

The utmost care should be used in the design of a golf course irrigation system, particularly a permanent system with automatic control. Some of the considerations taken into account when designing a system can be summed up as follows:

1. Determine the amount of coverage desired by working with the green committee and golf course superintendent.

2. Evaluate the water supply available.

3. Establish the number of hours and period, generally night hours, when watering is permitted on the golf course.

4. Determine with the aid of local agronomists and the golf course superintendent how much water is needed (generally expressed in inches per week) to meet the combined needs of the turf for evaporation and transpiration (evapotranspiration).

5. After proper analysis, select the sprinkler performance, spacing, and precipitation rate. This can vary for different areas of the same golf course.

6. Design the sprinkler layout as dictated by specific areas to be covered and by other factors, such as wind.

7. Determine the areas of individual control considering:

   a. Specific areas to be covered, such as greens, tees, fairways, etc. including size, shape and location.

b. Topography.
c. Shade and sunny areas.
d. Areas of air movement versus calm areas.

8. Establish sequence of control and segregation of areas controlled by various automatic controllers. It is definitely recommended that the control areas be kept as small as possible and that a minimum number of sprinklers operate on each control circuit. Also where economically feasible, we prefer to have a single control valve for each sprinkler. Even though we may operate a few of these simultaneously on the same station of the controller, this arrangement eliminates drainage of the piping through the low sprinkler heads and affords the most economical design of piping.

Where automatic control is utilized, the operating period for each circuit should be divided into two or three separate periods spaced a few hours apart so that a small amount of water may be applied initially to break the surface tension. Additional irrigation cycles are then utilized to apply the moisture at such a rate that it will penetrate into the soil. This we term "repeat cycling."

9. Selection of type of control — manual, semi-automatic or programmed complete automatic. Also specific type of equipment as type of sprinkler drive, hydraulic or electric control valves, etc. Both types of automatic control valves should be considered because many factors dictate which will perform the best on each specific golf course.

10. Design the distribution system.
a. Piping
b. Valving
c. Pressure control including booster pumping and pressure reducing plus flow control where necessary.
d. Water supply development, pumping, storage, etc.

11. Estimate the installed cost of the project.

12. Prepare specifications for the project including types of equipment and material to be used and construction methods the contractor is to follow. Wherever possible we use non-corrosive materials which includes plastic pipe.

It is my opinion that the person or firm who designs the golf course irrigation system should also supervise the installation, test the completed system, and supply to the owner as-built drawings and operating instructions. Who this person or firm should be is most ably expressed by Dr. John H. Madison, Jr., of the University of California at Davis. After an extensive study of irrigation systems including a substantial study of golf course irrigation he wrote:

"We cannot be tolerant of inadequate design. It is my belief that the trouble we find ourselves in is due to a misuse of the bid system. In asking for a bid we seldom present a sound set of specifications based on good engineering principles. Instead, most systems are designed by the same companies who are later going to bid on them. They know their designs will be competing in price with those of their rivals.

"To compound the problem, the supplier is often told to design to the sum which has been budgeted or which will be acceptable, when, in fact, the *bid should determine the cost and engineering the design—not cost, the design.*

"To me it seems the best answer to our present problems is to have the system designed by a private engineering firm which is paid directly (by the owner) and whose success depends on continually doing a good job of designing fully functional systems."

As a concluding thought, it appears advisable to point out that the permanent irrigation system with automatic control for golf courses is rapidly becoming a necessity for the economical and satisfactory maintenance of good golf turf.

COMING EVENTS

March 16-17	Michigan Turfgrass Conference Michigan State University East Lansing, Michigan
March 21	USGA Conference on Golf Course Management Americana Riverside-West Motor Inn Portland, Oregon
March 21-23	Royal Canadian Golf Assoc. Conference Inn on the Park Toronto, Canada
March 22-23	Wisconsin Turf Conference Wisconsin Center Madison, Wisconsin
March 23	USGA Conference on Golf Course Management The La Salle Hotel Chicago, Illinois
March 25	USGA Conference on Golf Course Management Marriott Twin Bridges Motel Washington, D. C.
May 24	Central Plains Turfgrass Field Day Lincoln, Nebraska