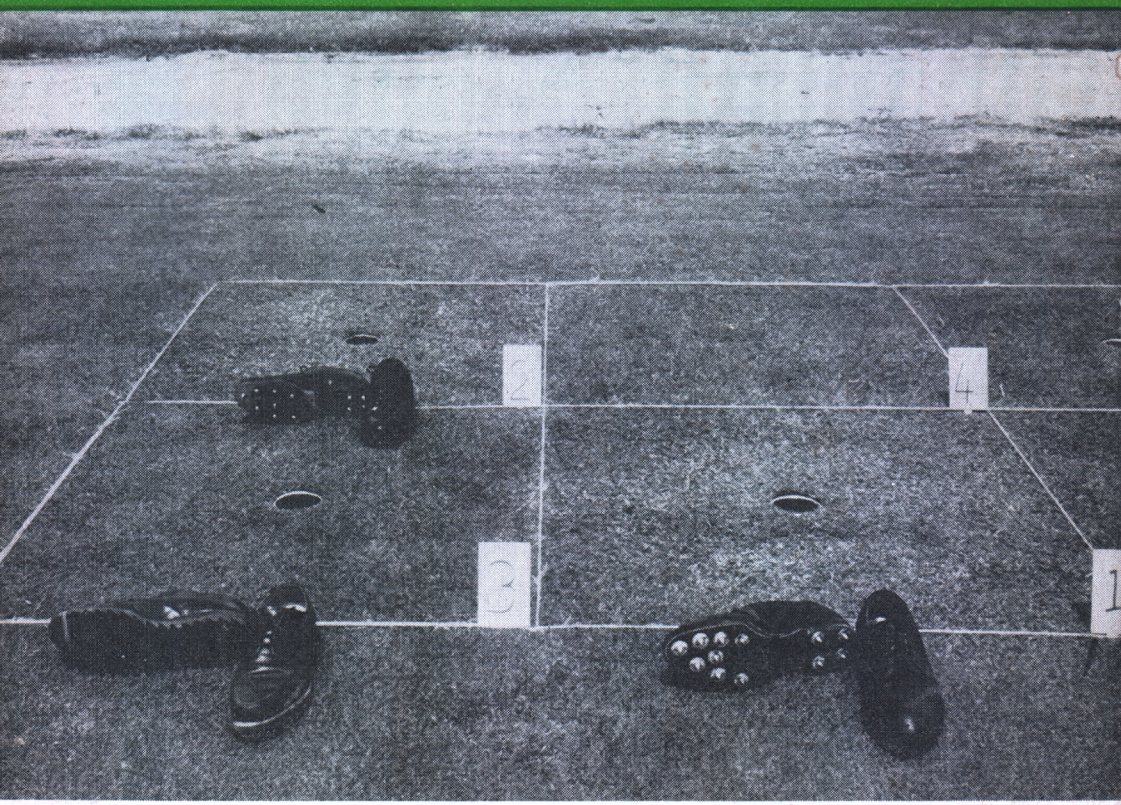
MAY 1963

USGA GREEN SECTION RECORD

A Publication on Turf Management
by the United States Golf Association



TRAFFIC ON THE GOLF COURSE

Plots after ten minutes traffic daily for 21 days by various types of shoe soles. *See page 3.*

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TRAFFIC ON THE GOLF COURSE

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The USGA Green Section Record: 1963

The Green Section of the United States Golf Association has recorded and published "information of value respecting the proper maintenance and upkeep of golf courses" for 42 years, in several forms.

From 1921 to 1932, 'The Bulletin of the Green Section' presented a tremendous quantity of knowledge previously unpublished. Later, 'Turf Culture' came into the picture but was discontinued during World War II. In 1940 'Timely Turf Topics' was begun and was a popular medium for dissemination of turf information during the war years and until 1948. 'The USGA Journal and Turf Management', first published in 1948, sought to combine Green Section material with information of general interest to golfers. The 'Journal' has served its purpose well for 15 years.

With the advent of the Green Section Visiting Service, there arose a need for a less formal publication to present short, timely, informative notes to the clubs in each general region served by the Green Section. The Regional 'Turfletters' performed this function.

Now, in an attempt to increase the Green Section's effectiveness, the functions of the 'Turfletters' have been combined with the 'Turf Management' section of the 'USGA Journal'. The new medium is 'The USGA Green Section Record'. Comments and suggestions from our readers are solicited. 'The USGA Golf Journal' no longer contains 'Turf Management'.

The first issue is devoted to one of the most urgent golf course problems of our day—traffic. These pages portray the thoughts of ardent students of golf course management about the matter based on their addresses in the Green Section's 1963 Educational Program entitled "Traffic on the Golf Course". Other parts of that program will be published in the next issue. It is hoped that every reader will gain something of value from this presentation.

Marvin H. Ferguson, Editor

The Traffic Problem

By WILLIAM G. BENGEYFIELD, Western Director, Green Section of the United States Golf Association

Imagine a large electronic board flashing lights on and off every few seconds. It is tallying America's population growth by the minute.

Every eight seconds a light flashes on indicating a birth; every 21 seconds, a death; every two minutes, an incoming immigrant; every 24 minutes, an outgoing emigrant.

When the tally is averaged, the net growth of our population is five human souls each minute, three hundred each hour — 7,200 each day. In just twelve years, 1975, the United States will have well over two hundred million people.

Now these are staggering thoughts, but what of our little world of golf and our growth problems? Traffic on the golf course is already a major problem. With a better than 20% increase in national population in the next ten years, we can expect more than 30% increase in the number of golf courses and better than 50% increase in the number of active golfers.

The majority of our courses were built in the 1920s or before. Al Radko points out that they were designed to accommodate about 250 to 300 rounds of golf a week, during their peak season; small tees and small greens are the rule. Today, we play that many or more rounds on a single day. Several California courses average 310 rounds a day for 365 days a year!

Golf is still played on grass, although we don't know how much longer this will be. You might ask, "How much traffic will grass withstand?" C. J. Cogan, Green Chairman at Irvine

Coast Country Club, Newport Beach, Calif., put it this way:

"One player, with 24 shoe cleats, will average 28 paces per green. 28 paces per green x 24 cleats = 672 impressions. 672 impressions x 18 greens = 12,096 impressions for one player. 200 players, a modest daily average, amounts to 2,419,200 impressions a day on 18 greens. 200 players a day for one month = 72,576,000 impressions!"

What of the various kinds of traffic on a golf course? I'm sure we all think first of the motorized cart.

Senator Ribicoff, of Connecticut, stated at a P.G.A. meeting in Florida: "Please, oh, please, keep golf a walking game. Don't let our fairways turn into highways. I want to be sure a good drive always means a good shot — not a fast tour in a motorized cart."

But carts are a part of the game today. They mean too much in player comfort, golf club profits, and faster play ever to be discarded. Indeed, golf carts are directly related to the boom in golf. But they are a problem and Marvin Ferguson has pointed out that we may be able to "live with them" if they are carefully regulated, if there is driver education, and if remedial measures are made through increased maintenance budgets.

But even worse than the motorized cart is the hand cart in causing turf attrition. There are more hand carts, and they are all over the golf course.

There is still another problem. Have you looked at the spikes on a pair of new golf shoes lately? If golf shoe manufacturers make spikes much longer, they will be in the agricultural machinery business. The length of spikes is becoming ridiculous for the purpose intended. You don't need a half-inch spike to gain a firm footing.

One of the loudest complainers about traffic on the golf course is the superintendent. I have heard one, in all sincerity, say, "If I didn't have to put up with those golfers, I could really grow good grass." Of course, he has missed the point. But the superintendent contributes to the traffic problem. Mowing machinery, tractors, jeeps, carts, spreaders, sprayers, etc., must all be used. Often the maintenance crew is not instructed to stay off collars, fairways, and tees whenever possible. Often a maintenance road cuts across a fairway when it might have been diverted behind a green or a tee.

Just what the solution is to the transport problem on a golf course, I do not know. But, let's face up to it. Increased traffic has brought us many new problems. In addition to soil compaction, turf deterioration on tees and collars, ruts, holes, skid marks, and what have you, we must now contend with path maintenance and upkeep, traffic direction, signs, and continual education of new golfers as well as new maintenance personnel.

This is difficult because people play golf for fun and recreation. They resent any list of "do's and don't" on the golf course.

Perhaps, with our growth in numbers and technology, we are also going to grow in "awareness and literacy." Dr. Hans Bethe, noted Cornell physicist, has remarked about the need for science education — not merely to produce more scientists but to create a new literacy in the general public in science. Science for the educated layman is becoming a practical necessity in daily life.

In similar manner, as educational institutions bring us to a higher level of understanding, we may hopefully find a greater appreciation among golfers of the traffic problem. The creation of a new and needed understanding on any subject is not impossible.

Effects of Traffic on Turf

By MARVIN H. FERGUSON
Mid-Continent Director and National Research Coordinator, USGA Green Section

The effects of traffic are apparent to the casual observer as worn spots in turf, as discolored turf, and as bare soil showing through sparse, trampled-down vegetation.

The most common damage is simple bruising. Traffic from street shoes may not produce injury immediately visible. However, bruising does damage structural elements of the plant. It ruptures some cells. It disrupts the plant's rather elaborate "plumbing system". Frequently the leaf blade dies after such injury.

Turf under moisture stress is more likely to be severely injured than turf well supplied with water. Turgid cells are not as susceptible to rupture of cell walls as are cells which are flaccid and limp. Compare a tire filled with air with one flat. The tire with adequate air pressure supports the weight of a vehicle with no harm to the tire. But when the tire goes flat, it is soon ruined. Similarly, the turgid cell supports weight without injury and the flaccid cell does not.

In such superficial damage as bruising of leaves, grass recovers quite quickly because leaves are regenerated easily.

But if injury goes deeper and you begin to damage the crown or the roots of the plant, you inflict a much greater injury and one from which the grass plant recovers more slowly. This is an important point, because later we want to emphasize distribution of traffic insofar as possible. The reason for that is that you can inflict superficial damage to leaves and turf will recover quickly; but when you damage the plant more severely by prolonging traffic, you slow down its ability to recover.

A divot represents a type of damage that takes a long time to recover, because you removed not only the leaves but the crown of the plant and a part of the roots. New plants have to be developed to fill in this area. If the torn area is topdressed immediately and filled with soil before all the underground growing parts dry out, it will recover from the damage much more quickly than if the area is allowed to dry out before it is topdressed.

Another type of damage is indirect. Traffic bruises the plant at a critical time and predisposes it to disease injury. It is common that the most seriously damaged part of a putting green suffering from disease activity coincides with the area where the flagstick was last placed. Sometimes even single footprints are apparent.

You may wonder why traffic would have anything to do with disease. It bruises the leaves and makes a ready entry point for fungus growth. It further presses the healthy leaves into the turf and down into the mat. If the green is wet and the healthy leaves are pressed down into the mat where the disease organisms may be living or simply biding their time for a chance to attack, you have the combination of bruising the leaf and pushing the grass into contact with the inoculum.

Speed of recovery of turf from injury depends upon a number of things —the strain of grass, management practices, the severity of injury.

Therefore, the most important thing to remedy damage to turf is to distribute traffic. We can move tee mark-

Damage to Seaside bentgrass after 630 traverses during 6 weeks in 1958 by: left—ripple sole shoes; center—rubber lug sole shoes; right—conventional spiked shoes. Ripple sole shoes produced least damage, conventional spiked shoes greatest damage.

Above, Seaside bentgrass 6 weeks after traffic experiment 1959. 1—conventional spiked shoes; 2—modified spiked shoes; 3—ripple sole shoes; 4—check, no traffic. Note weeds and algae in 1.

Below, close-up of Seaside bentgrass after 5 weeks traffic (10 minutes daily) with conventional spiked shoes. Soil appears extremely compact; grass stems and leaves are pressed into soil. Spikes penetrate soil, leaving all of the golfer's weight resting on metal shoulders surrounding spike.

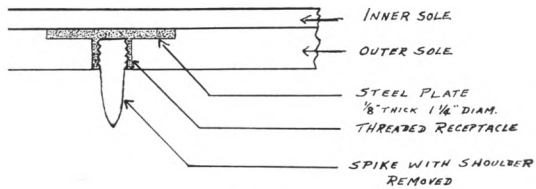
ers quite frequently so we don't inflict serious damage on turf before it gets a chance to recover. We can move flagsticks quite frequently. We must do everything possible to allow recovery time after grass has been injured so we don't get down to tearing the very heart out of the plant.

Work was done at Texas A & M in 1958 and 1959 on types of soles and spikes on golf shoes (reported in the USGA JOURNAL AND TURF MANAGEMENT for November, 1958 and September, 1959). Essentially, the experiment consisted of comparing wear resulting from shoes of different kinds.

An early test consisted of walking in a straight line across putting green turf and noting the damage resulting from the use of conventional golf spikes, lug soles, and ripple soles (Figure 1). Conventional spikes were most damaging and ripple soles least damaging.

Because the elements of turning, changing direction, and "body English" were missing from this type of exposure to wear, a second test was devised in which the experimental plots were 3-foot squares. The squares were marked off, a cup placed in the center of each square, and a man spent ten minutes each day for five weeks putting a ball into the cup, retrieving it, taking his stance, and putting again. In this study, the shoes were the conventional golf spike, the ripple sole shoe, and a modified spike (see front cover). In the modified spike, the shoulder was removed from the spike, and a circular disk which would support the receptacle containing the female threads was welded to the receptacle and placed between the inner sole and the outer sole of the shoe. Thus, only the spike itself protruded (Figure 2, and above).

After five weeks the experiment



Position of a steel disk welded to the base of threaded receptacle. Only spike protrudes beneath shoe sole.

was abandoned. At that time, plots on which both the conventional and the modified spike had been used were badly worn (Figure 3). Ripple sole plots sustained moderate damage. Plots were allowed to recover, and six weeks after the removal of traffic they were again evaluated. The plots where the modified spikes and the ripple sole were used had made complete recovery. The plot on which the conventional spikes were worn had a partial turf cover infested with weeds and a growth of algae (Figure 4). Thus, it appeared that the compacting effect of the shoulder around the conventional spike produced more lasting injury than any other factor involved.

In summary, any kind of traffic is damaging to grass, but grass has a remarkable ability to recover from light injury. It is damaged permanently when the wear is prolonged to the point where the regenerative tissue of the plant is destroyed.

Thus, it would appear that the most effective single device the superintendent may use is frequent rotation of movable features such as flagsticks, tee markers, ball washers, and benches.

There is no way to *make* grass grow, but you can *allow* it to grow. The statement has been attributed to Professor Lawrence Dickinson that one should "let the little grass plant grow—you can't make it grow—but it wants to grow—you help it."

Planning of Golf Course Features

By RICHARD S. TUFTS, Former President, United States Golf Association

Generally speaking, there are two kinds of traffic on a golf course-first, that which relates to maintenance of the course; secondly, that created by play.

Except for the putting green, the first general grouping is today largely concerned with passage of equipment over the course. The second has traditionally been foot traffic until the recent development of vehicles used for transportation of the golfer and the increasing use of the hand-drawn cart for golf bags.

In the effort to regulate traffic over the course, it is obvious that concentration of traffic is to be avoided. This can be accomplished either by removal of traffic from critical areas or by distribution over as wide an area as possible of traffic that cannot be diverted. The purpose of this study is to consider the means by which the various types of traffic can best be diverted or distributed.

The first of our two groupings is quickly disposed of for the simple reason that, regardless of design or arrangement, equipment must pass over all turf surface for the purpose of maintenance. It is hardly possible to divert maintenance traffic. But there are several ways in which this traffic becomes concentrated due to lack of space or because design is not adapted to the equipment used.

Typical of this is the need to provide as much level space as possible for turning equipment, especially for green mowers, and the shaping of such features as bunkers and fairways to provide for mowing the course by the continuous passage of equipment without returning over an area just covered and with an opportunity to vary the pattern of mowing as much as possible. This is a practical problem and its solution must be found on the course.

From an architectural standpoint, there is no reason to make any sacrifice on this point; courses experiencing wear due to avoidable concentrated use of equipment should certainly consider changes in their present layout. Everything must be carefully planned with the bunkers, rough, etc., arranged to give the proper width of cut for the equipment used.

We now come to the second general division—traffic created by play. We may meet with some success in control of the path to be followed by maintenance employees, but there is no way to direct the path of the golfer, nor, for that matter, can the golfer himself always be wholly successful in the direction of his own route. We would be defeated should we attempt to establish an exact route for the golfer; we must depend largely upon subtle devices to entice him into following the path we wish him to pursue.

However, there are some aspects of play over which we can hope to exercise a little control. Although there is nothing we can do about the golfer relentlessly in pursuit of his ball, it is not necessary for the golfer's caddie and his equipment, like Ruth, to go every place that he goes. For example, only the caddie who is to attend the flagstick should be permitted on or near the green. All caddies should be trained to deliver the player's driver to him as he leaves the green and then to proceed down the fairway to some position from which they can best watch the flight of the ball. Only on

par 3 holes should there be any reason for caddies to add to the traffic problem around the tees. Keeping caddies away from tees has an added advantage in making tee seats available for the golfers.

Routing Golf Carts

The routing of the golfer and his cart is more difficult. If the cart is for transportation of clubs only (for which hereafter we shall adopt the British term "trolley"), then the best we can hope to do is prohibit the use of trolleys on the surface of tees and greens. We should also attempt to educate the golfer to keep trolleys away from the green apron, but there is small hope of accomplishing much in this direction without signs and paths.

We have much the same problem when the golfer's cart is for his personal transportation (which we shall hereafter refer to as an electric cart, regardless of the fact that some may use gasoline.) Paths for electric carts should be built around tees and greens; these paths should be well marked with signs. On some courses electric carts have been so injurious to turf that either paths are provided for the entire course or carts are not permitted on fairways. This may be a good arrangement for the superintendent, but it would not seem to save many steps for the golfer.

There are, of course, means other than cart paths which can be used to control electric cart traffic. An artificial step or a steep slope may be introduced on the path to a tee to keep carts away. Slopes or wet areas should be eliminated to put areas into use which we want them to use.

Regardless of how we may feel about use of electric carts by those who would be benefited by the exercise they seek to avoid, we must recognize that the golfer is our customer and that we should do our best to give him what he wants. The superintendent should only expect that golfers comply with reasonable regulations in the use of carts and that the maintenance budget be increased to allow for the added cost certain to result from their use.

At many courses it is a requirement that a caddie, if available, go with each electric cart. Under these circumstances a substantial improvement in the traffic problem can be made if the caddie is trained to drive the electric cart.

Thus, as play approaches the green, the two players leave the cart at the point where signs direct traffic away from the fairway; the caddie drives the cart to a point between the green and the next tee. The caddie then returns to the green with any clubs needed to complete the hole, such as a putter. While the players are on the green, the caddie places the other clubs in the bags on the cart and proceeds on foot down the next fairway to act as a forecaddie.

This practice pays a handsome bonus in saved time. The speed of play on a golf course is fixed by the time required to hole out around the green. Use of electric carts definitely slows up play around the green by the time required for the player to go to where the cart has been left, either to get a different club or to take the cart to the next tee. Thus, by working with the caddiemaster in training caddies, the superintendent can save needless wear on his turf, speed up play, and improve the service which the player receives from his caddie.

This about concludes the list of weapons available in the battle to reduce traffic by regulation. We come now to the subtle approach — an attempt to regulate the movement of the golfer by inducements. Here we are almost

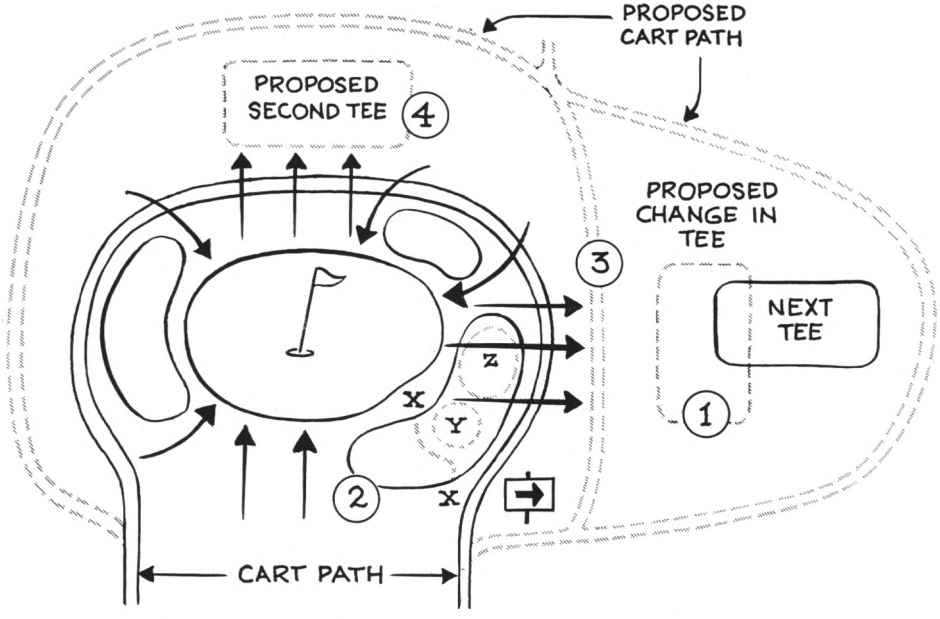
exclusively concerned with the play around the green and the next tee. Through the fairway, traffic will be pretty well distributed by the inherent inaccuracy of the golfer. But sooner or later he will reach the green and, having holed out, will move on to the next tee. Since it is here that most severe maintenance problems are met, it is worthwhile giving careful consideration to this traffic area.

The drawing is a plan of an imaginary green and tee. Probably no architect would ever build a green like this, but it has been designed not for play but rather to illustrate in one example all the various so-called inducements we are going to discuss.

This green is pretty well surrounded with bunkers. A cart path is very conveniently located between the green and the next tee. If there is any good cupping surface on the right part of the green or if the apron there is in good condition, it could only be because there is very little play on this course. The concentration of traffic here is so extreme that it seems silly to imagine that a hole like this would ever be built.

There are four features of this hole which concentrate the traffic on one area. The average golf hole would probably have only one of these four features, but the elimination of even one can help materially to lighten the traffic burden.

First, consider the shape and relative location of the tee and the green. Both are rectangular and located on a common axis. This means that both tee and green carry the maximum possible traffic. It would be much better



Solid Line: Original Plan *Dotted Line: Proposed Changes*

if the two axes were parallel in order to obtain a better distribution of traffic between them (No. 1 in diagram).

Next, consider the beautiful big bunker on the right front corner. It means misery for the small area of turf beyond. By cutting the bunker off at the dotted line X-X, building a little mound at Y and a grass hollow at Z, a great deal of expensive bunker maintenance is eliminated; the whole side of the green is opened up for traffic, and the playing characteristics of the hole are improved. As for playing characteristics, bunkers around a green perform two functions—to penalize the poorly played shot and to frame the hole and serve as an aid in estimating distance. Neither function is affected by the proposed change. As far as play around the green is concerned, a chip shot from a hollow is just as difficult for the expert as an explosion shot from a bunker. (No. 2).

Locating Cart Paths

Third, let us consider the location of the electric cart path. It is creating traffic over an area between the green and the tee that already carries its full share (No. 3). The electric cart can travel much more quickly than a golfer can walk. Why try to provide a short cut for carts? After all, a cart path is easier to maintain than a compacted fairway.

The best path is around the far side of the tee, with the stopping place for carts back of the green, where the traffic problem is not serious. This has the added advantage of placing the cart in a position which will bring the golfers off the green most quickly and will therefore open up the green sooner for players following. Also, some traffic will be saved if there are two cart paths around the green instead of one. Thus, the golfer whose ball is on the left side of the green will not have to cross the entire green from the cart path on the other side.

Finally, the use of a second tee for the next hole can help in distribution of traffic (No. 4). This can be a front tee or a ladies tee, and if possible it should be located along a second side of the green and at a point where there will be no bunker between green and tee.

Now the flow of traffic in and out is in a fairly reasonable pattern for even distribution, made possible by some rather simple changes.

One final weapon available to the superintendent in his battle to control traffic is the location of equipment which relates to play. Obviously, the hole can be moved around on the green to give relief to the areas which show signs of wear. However, in doing this some consideration should be given to the golfer. All 18 holes should not be placed on either the front or the back of the greens on the same day.

A sense of balance must be maintained in placing tee markers, with consideration to the playing length of the course for handicap purposes. The relative location of flagstick and tee markers can be varied to give quite a variation in the traffic pattern.

Ball-washers can be moved about either to provide a varied path for traffic or to divert it from a well-worn area. If a path to the tee has been developed, it can be closed off by putting the tee bench across it or in a more permanent fashion. The opening of an attractive vista can be used to shift traffic into a more desirable pattern.

There is not really much to all this except the exercise of good common sense. The superintendent should not hesitate to ask for the cooperation of the caddie-master and to recommend structural changes that would be helpful.

Effects of Traffic on Soils

By DR. R. R. DAVIS, Ohio Agricultural Experiment Station

I. Traffic can disfigure the soil surface.

A. Dry soil will not rut but repeated traffic to remove sod will pile up dust in track. (Figure 1) Tracks going up and down slope can cause erosion.

B. Traffic on soft soil will cause rutting (degree depends on tire and weight). (Figure 2)

II. Traffic can press soil particles closer together (compact). A normal soil is about 50% by volume solids and about 50% space occupied by either air or water. Compaction eliminates many of the larger spaces. Compaction is measured by resistance to penetration, change in size of pores, volume weight and others. Amount of compaction depends on many factors other than pressure per square inch and frequency of application of pressure. Some important factors are:

A. Soil texture: The fineness of solid particles—how much sand, silt and clay is in the soil—organic matter. Fine-textured soils (clays) are more subject to compaction than coarse-textured soils (sands). Hence the current recommendation for large quantities of coarse sand in greens construction. The texture also influences the amount of large pore space.

B. Soil moisture: When soil is very dry, it is difficult to compact. When soil is saturated, it is a hydraulic system and will not compact but will displace. Soil is seldom completely saturated in nature. Moist or wet soil will compact.

III. Effects of compaction.

A. It reduces non-capillary pore space.

B. Inhibits infiltration and percolation of water.

Figure 1

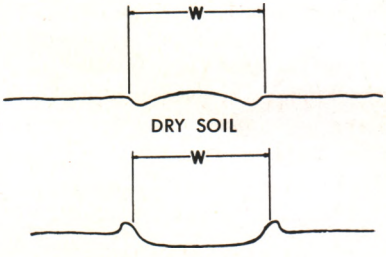


Figure 2

C. Reduces oxygen diffusion in the soil.

D. Inhibits root development.

E. Changes plant community - Knotweed, *Poa annua*, other weeds invade bentgrass or Kentucky bluegrass where there is excess compaction.

IV. Unanswered questions.

A. Is it better to make twice as many passes over a given spot with a 12-inch wide tire than one-half as many with a tire 6 inches wide?

B. Does surface compaction hold over from one year to the next or is the compaction corrected by freezing and thawing in cold areas?

C. How much compaction can be tolerated and still be able to produce a good turf?

Roads on the Golf Course

A PANEL DISCUSSION AMONG:
JAMES B. MONCRIEF, Southeastern Agronomist, USGA Green Section — Moderator
CHARLES DANNER, Supt., Capital City Country Club, Atlanta, Georgia; Member, USGA Green Section Committee
LEE RECORD, Northeastern Agronomist, USGA Green Section

CHARLES DANNER:

Since golf carts made their debut, our thinking on damage to the golf course by cart traffic has undergone radical changes. We are sure of one thing—the carts are here to stay; and our maintenance practices, green and tee construction, and paths where needed must be given consideration.

However, most damage from cart traffic is in areas approaching or leaving tees and bridges where traffic is concentrated.

This concentrated traffic has resulted in badly worn areas or paths. Ground cover is worn off, and compaction makes it almost impossible to grow grass.

At first we ignored this condition around tees but then came to realize that these worn areas and paths created conditions ready made for accidents for cart users. With the ground cover lost, erosion had set in, making the path rough, uneven, and extremely hazardous. Last year one man was killed in Atlanta when a cart overturned. At Capital City Country Club, two persons were hurt in separate accidents, fortunately not seriously.

At Capital City we started a program of paving paths approaching and leaving tees. We have widened and paved bridges and built safety railings where needed.

We have a golf course modernization program with nine holes finished and the back nine scheduled for construction this spring. Every green on the front nine was built to keep carts from using the green shoulders or borders. Subtle barriers in placement of sand traps and, in some approaches, steep slopes were built in, with the thought that future cart traffic was bound to increase.

Our cart paths are paved with hot-mix asphalt, six feet wide where used only for carts and eight feet wide where the path follows a road used by golf course equipment. Where paths end, they are fanned out to twelve feet to minimize damage where carts leave them.

Paths should be cut out to a depth of six inches, and more for equipment use. This assures removing bermudagrass roots so that the bermuda will not grow back through the asphalt. Six-inch depth seems enough in the heavy clay soils of the Atlanta area, but in sandy or loamy soils spraying the soil with 2 pounds sodium arsenite to 1000 feet might be necessary to prevent recovery of bermudagrass. Six-inch depth is all right in Atlanta to prevent damage from freezing and thawing, but farther north the materials might have to be thicker.

We do not use boards or metal strips along edges; the paths are paved flush with the ground, so mowing over is no problem, and the bermudagrass and soil will keep the edge from breaking off. One problem is bermudagrass creeping onto the path. This can be controlled by edging or applying sodium arsenite or dalapon.

Construction is started by using a rotary cultivator to loosen the soil to a depth of six inches. This soil is removed by a front-end loader where

feasible and shovels to finish and true up the excavation. Crushed stone, a material graduated in size from 1½ inches down to dust, is spread to a depth of three inches and packed by rolling before paving with three inches of asphalt.

Where the path follows a road used by golf course equipment, we cut deeper and pave with five inches of asphalt instead of three inches.

In paving, we have a five-gallon container filled with kerosene to keep tools and roller clean. The tools can be dipped in the container and a large brush used to apply kerosene to the roller to prevent asphalt from sticking.

Hot-mix asphalt is dumped in the path and spread by shovels and rakes, smoothed with a board paddle and, after cooling, rolled. We used a power roller weighing 500 pounds. It did the job satisfactorily for the Atlanta area, but farther north a heavier roller should be used to seal the surface better to prevent damage from freezing.

Paths are peaked toward the center to prevent a golf ball from stopping on them. After rolling, the asphalt is allowed to set overnight before being opened for traffic.

Costs of materials and hauling vary. A base to start figuring costs might be that for both crushed stone and asphalt, 100 pounds of material are needed for one square yard per inch of thickness.

JAMES B. MONCRIEF:

Many courses have the advantage of being built on soils that make excellent cart paths without much change in the natural soil. Those with sandy-type soils have the advantage over those built on clay soils, especially when the weather is wet and the "no-cart" sign goes up. Courses with soils of sand and clay mixtures can have excellent cart paths when these soils are rolled. In most cases, however, these two ingredients are not found in the proportions necessary for ideal cart paths. Usually the addition of either sand or clay is needed.

More often, it is necessary to use a more stable material than that found on the site. Gravel or crushed rock seem to be the choices for base material with clay soils. Aggregate sizes range from dust to large rock. It is desirable to have a mixture of various sizes so voids will not cause depressions later. Dust, by-product of rock crushing, makes an excellent base for roads or cart paths. Small aggregate has the built-in safety factors of minimum damage to mowers and minimum danger of injuring players by rocks thrown by rotary mowers. Larger aggregate can be used where this hazard is not a factor and a heavy base is necessary to support the traffic.

The larger aggregates make excellent bases for roads and should be firmed in place before any other material is put on top or should be retained in place if no smooth surface is planned to cover the rock. It is advisable to cover large aggregate with a small aggregate before paving or applying asphalt.

Rarely are cart paths finished with anything other than asphalt. A great deal of pertinent information is available from THE ASPHALT HANDBOOK, published by the Asphalt Institute. In some instances, concrete is used. Other materials utilized are sea shells, coal cinders, straw, pecan hulls, rubber waste, and other local materials that prevent rutting and

slipping of equipment.

About five colors are available in asphalt. White is being experimented with but, due to cost, is not available for construction now. There are various blends of asphalt for rapid cure, medium cure, winter use, and summer use.

It is best that all asphalt be well sealed when rolling; usually a heavy roller of 2,000 pounds or more is advisable. Lighter rollers may be used as long as the surface is well sealed. The Athens Country Club, Athens, Ga., used its tennis court roller, and so far the results have been very satisfactory.

Where a cart path is steep, erosion can be a problem. Turf on either side of the path may be thinned out unless water is diverted by using asphalt or soil. Also, golfers walking at the side encourage erosion. Most do not walk on an asphalt cart path, but on turf. Many players have the feeling that asphalt wears out their spikes faster than sandy soils. Asphalt is much better to walk on with spikes than concrete.

Since people are used to highway markings, painted directional indicators on cart paths can be used to advantage.

LEE RECORD:

Thorough long-range planning is necessary in establishing service roads. How should we design them so that they will be desirable esthetically and of greatest advantage? Design is important in establishing desirable playing conditions and agronomic flexibilities which may enter the picture—erosion, flood control, and drainage of waste water.

Two types of design may be used—the solid roadway and the ribbon road where only tire strips are necessary. It would be desirable to have solid-paved roadways around the entire course, but we don't want to lose esthetic values and have the course look like a sports car race track.

A most important factor is the location of the maintenance barn in respect to location of service roads. Main arteries should be looked at, as direct routes to specific locations, such as one road in connection with incoming deliveries (fertilizer, lime, sand, etc.); this main artery may also be useful for deliveries to the clubhouse. Another important road is the golf cart road between the building in which carts are stored and the first tee.

Road design is very important. A road slightly raised in the center would be especially desirable for quick water run-off or possibly limited water diversion. With this type, a ball would be less apt to remain on the road surface.

Another type is concave, the reverse of the above mentioned. It is excellent in connection with water diversion, especially on hilly terrain. The depth for the center of the road need not be extreme, but enough of a swale is required to control water flow and run-off. Other designs of solid-surfaced roads are the flat surface and the flat surface with small raised curbs.

Where a solid road is not practical due to budget limitations, consider the ribbon or strip path design. This is useful in erosion control on slopes, and it may be used in water diversion. The width of the ribbon will vary with equipment on hand, but an average width is two to three feet.

Rough areas are the most desirable for roads, outside the rough mowed areas, as they may be concealed and not interfere with play.

USGA GREEN SECTION RECORD
40 East 38th Street, New York 16, N. Y.

TURF TWISTERS

Question: Are we poisoning the soil under turf by the continual use of chemical fertilizers, weed killers, and fungicides? Aren't these materials hazardous to humans?

Answer: We think not. Most of the elements found in fertilizers and pesticides are present also in the soil. It is the *combinations* of the elements in pesticides which make them behave as toxicants. The soil has a remarkable ability to absorb these materials and to convert them to non-toxic forms. As far as fertilizers are concerned, it apparently makes little difference to the plant whether the nutrients are supplied in inorganic (chemical) form or in organic (natural) form. It is believed that the nutrient elements are taken into the plant in the ionic form. Thus, it makes little difference whether an ion of potassium is derived from potassium chloride or from wood ashes.

The second part of the question would lead us to believe that the questioner is overly concerned about the safety of chemical materials used on turf. Some materials used in turf management are extremely toxic to humans. However, they have been thoroughly tested, and they may not be marketed until Federal control agencies are completely satisfied that their proper use will pose no danger.

Note that we have said *proper use.* When improperly used, even common products such as aspirin or table salt can be hazardous. One need not be afraid of chemical products used on turf if he *reads and heeds* the label instructions.

Question: How does one recognize damage from the Eriophyid mite on bermudagrass? Please recommend a control.

Answer: The damage is very characteristic. Once seen, it will be easily recognized thereafter. The symptoms of injury are shortened internodes. This shortening causes leaves to arise in tufts or witches' brooms.

Diazinon has provided effective control. Mix with water at the rate of one fluid ounce of 12½ percent technical diazinon to one gallon of water; apply at the rate of 5 gallons per 1,000 square feet. In granular form, 10 pounds of 5 percent granular material per 1,000 square feet has provided effective control.

Very finely ground sulfur at the rate of 10 pounds per 1,000 square feet has been effective.