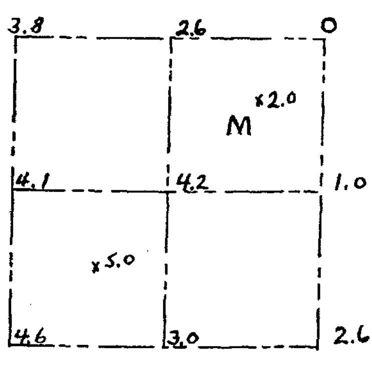
"Curiously enough, this question is answered by the very same paragraph in the rules which answered your first question, namely, the last paragraph of definition 6, in which it states that it is the duty of authorities in charge to define their hazards by local rules. If, therefore, you do not like the general practice of the break of the bank as the margin of the hazard, you may define the margin in any way you see fit."

Cost-Estimating in Green-Construction

LOUIS B. HARRIS, *Wilmington (Delaware) Country Club.*

The *great unknown in cost-estimating in green-construction* is the transformation of the pictured green in the architect's imagination into the material earthwork that must actually be involved in the process of construction. The difficulty itself apparently lies in the fact that the representation on paper of such an irregular mass of earth as is a green does not lend itself well to most of the accepted methods of representation. The methods of representation outlined below, which have been successfully employed by the writer, are the results of an attempt to find a solution for these unknown cost-factors in green-construction. And, working under the theory that the cost of representing the architect's ideas in rough earthwork is the principal unknown involved, the following suggestions should result in lower construction costs, due to the fact that the plan is specific in mechanical detail, rather than general.



ZERO — LOW POINT

Fig. 1.

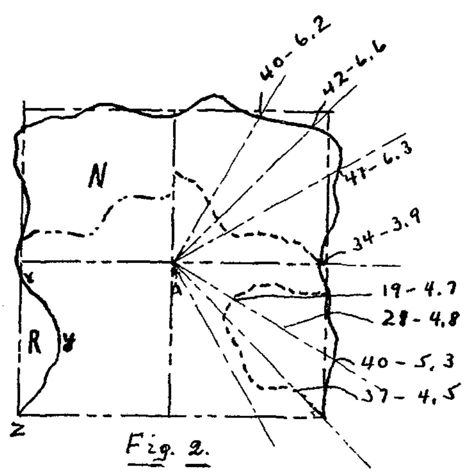


Fig. 2.

A is 4.6

Greens usually describe the shape of a square, a rectangle, a parallelogram, or some other polygon. When the architect has determined the shape and size of the green in polygon form, the first step will be to determine with a level the vertical relation between a number of points. These will be called *conformation figures* (figure 1). The next step will be to construct the green, giving the mechanical detail of the points felt advisable (figure 2). The figures "42-6.6" mean that, 42 feet from A the green should be 6.6 feet high, or, rather, 2 feet higher than A, which is 4.6 feet. A can be any point in the green, and should be the first point determined, inasmuch as every other point is dependent on it. The diagonals through A are 30 and 45 degrees. Figures of height should allow for shrinkage.

The conformation of the ground should influence the design. Too often a horizontal plan accompanied by written instructions describing various elevations, will not conform to conditions that exist. Because of this lack of detail, a green might be elevated far more according to plan than the architect had in mind. A one-foot error, or, more properly, a one-foot rise more than necessary, may result in an added expense of a hundred cubic yards or more. (Bear in mind the relation in volumes between packed and loose soil.)

In addition to the fact that individual ideas of the architect can be incorporated as usual, the positive check given to the constructor is conducive to fewer errors and practically eliminates guesswork, which, in addition to confusion in handling teams, often results in costly duplication.

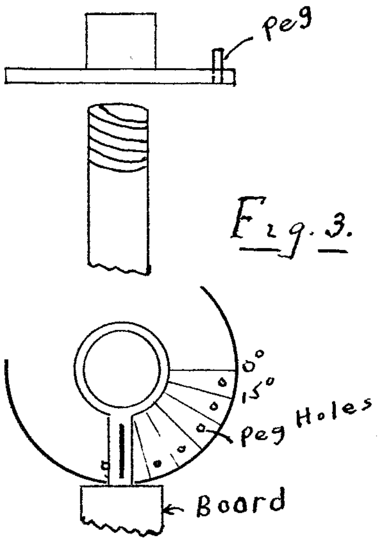


Fig. 3.

A simple instrument to help the constructor carry out the detail, consists of an iron stake with a plate graduated every 15 degrees screwed on the top. A long iron rod or board, with a small level screwed in, graduated in feet, can be devised to hook over the top in such a way that the rod can be swung around. Figure 3 illustrates the construction of the top part of the instrument.

Estimating.

Estimation is based on geometric figures. The fill required will be equivalent to the air space taken up by the finished green or, putting it another way, the sum of the cubic contents of all the polyhedrons filling the air space plus percentage added for shrinkage, can be calculated in dollars when the source of the fill has been determined and with knowledge of scoop-, wagon- and man-hours necessary to move and locate that amount of fill. If the fill is taken from different sources, the contents from each source can be approximated by the same method.

To explain the principle in an easier way, suppose we want to find the volume of a square block of wood. Saw a cube out of the block, measure it and calculate its volume, and then saw another cube out of the block and make the same calculations on it, and proceed in this manner until the block has been completely sawed up; the total of the volumes of the cubes will be the volume of the block. A green can be calculated in the same way, except that polyhedrons of various kinds, instead of cubes, are taken out until the green has been completely "sawed up." A green is designed according to dimensions, and it is simply a matter of piecing out polyhedrons from the measurements on the plan.

A polyhedron is a solid with flat sides. A cigar-box, the Washington monument, a diamond, and the pyramids are typical examples. It may have any shape as long as it is a solid and all the sides are flat. The most useful polyhedrons for this work, with their formulas for volume, are the following (the symbol h meaning height, and B area of base).

PARALLELEPIPED. Volume is B times h. Analogous to a match-box pushed into any shape where opposite sides are parallel.

TRIANGULAR PRISM (figure 4). A polyhedron where two opposite faces

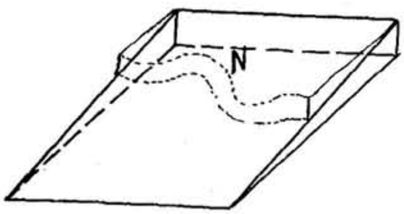
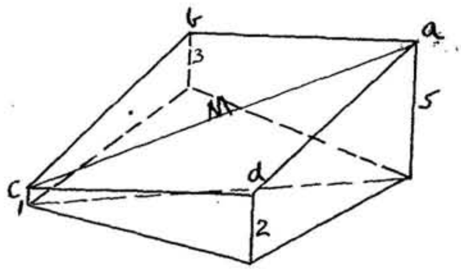


Fig. 4

DOTTED LINE IS PLATEAU.



B IS AREA abcd

Fig. 5

are equal triangles and parallel, and where the other faces are parallelograms. Volume is B times h.

TRUNCATED TRIANGULAR PRISM. Volume is 1/3 B times the sum of the lateral edges. Where a triangular prism is standing on its triangular base and a plane not parallel to the base cuts through it, the result is a "truncated" triangular prism.

A very useful figure (figure 5), with no name, is composed of approximately two truncated triangular prisms. Volume is 1/3 B times (2a + b + 2c + d), where a and c are opposite edges. Application will be shown later.

In dividing the finished green into geometric figures, either a square, a rectangle, a parallelogram, or some other polygon should be drawn in such a way that the best average of the contour of the green is included. Sometimes it is necessary to add a triangle to the above to take in all of the contours. It seems advisable to keep to straight-line figures, rather than curves, for simplicity, although a small discrepancy will result. Final calculation is facilitated if the division of polyhedrons is made two steps,

(1) assembling polyhedrons to bring the green level, and from this level (2) assembling polyhedrons to bring the green to the desired elevation. For example, where the ground falls away from the approach, conceive a level plane drawn from the front edge of the green, or, where the front edge falls to the right or left, a plane through the ultimate front edge; then assemble the geometric figures below this plane and above this plane for the final sum.

In figure 1, to bring M level represents a frequent case where vertical distances at the four corners of a square are different. This figure is the last mentioned above (figure 4), where a and c must be at opposite corners and should be the smallest and largest heights, if possible. This geometric figure, although an approximation, is most valuable for quick work, and is probably used more than any other.

Assume that the fill has been brought up to the level plane and that a uniform rise away from the approach is desired. A triangular prism is described (figure 4) whose base (B) will be a triangle, one side of which is the distance between the beginning of the rise and the back of the green and the other the height of the rise at the back, and whose height (h) will be the width of the green. Suppose a plateau is desired (dotted line N, figures 2 and 4). This describes a figure similar to one-half a prism, where B is area N, which can be approximated on graph paper, and h is the vertical rise at the dotted line. Volume is ½ B times h.

In R (figure 2) we find the contour line breaking away from the square, where subtraction seems warranted. A truncated triangular prism is formed, whose base is triangle xyz and lateral edges are vertical distances x, y, and z.

Calculations so far leave the sides vertical. To fill out to a proper slope, imagine each side a frustum of a pyramid (a pyramid truncated in such a way that the cutting plane is parallel to the base). The formula for the volume is, 1/3 h times $(B + b + \sqrt{B \text{ times } b})$, where b is the area of the triangle at the smallest part and B is the area at the largest part and h is the height. The total sum, in cubic feet, converted into cubic yards, with shrinkage taken into consideration, gives the cubic-yard fill for the green. It seems advisable in making a diagram for estimation, to use vertical figures for packed soil and add a percentage for shrinkage.

The greatest advantage in using the above method of design, outside of cost estimation, is its assistance to the constructor. Much duplication of labor can be avoided if the constructor knows before starting work exactly where each scoop-load or wagon-load should go.

When the contours have been determined, draw 30- and 45-degree lines through the point A. Using figures 1 and 2 for illustration, the architect desires the point where the 45-degree line intersects the contour in the upper corner to be about 4/5 feet higher than A after the green has settled. Assuming shrinkage to be 25 per cent, the calculation is as follows: 4.6 feet, minus 1/10 foot for shrinkage of A, or 4.5 feet, plus 4/5 feet, which equals 5.3 feet, times 125 per cent, which equals 6.6 feet. The constructor will therefore know from the drawing, and using the instrument described, that he has reached the proper elevation when this point is 2 feet higher than A. An indefinite number of points can be given in the drawing.

Calculation of points does not take as long as imagined at first glance; in fact, a large number can be determined by inspection. Thirty points can be checked by the constructor in ten minutes; and even though he may use only half of the points on the drawing, too much detail is better than too little. These points will be a constant reference to the constructor.

A Control for Japanese Beetle Larvae in Golf Greens

B. R. Leach and J. W. Thomson [1]

The larva of the Japanese beetle (*Popillia japonica* Newn.) has become a serious pest in golf greens. The rich soil and heavy turf of the greens attract the beetles, and eggs are deposited in enormous numbers during June, July and August. Under these circumstances it is not unusual subsequently to find as many as 300 larvæ to the square yard of turf. The larvæ feed upon the grass roots, and by late August or early September the turf begins to turn brown and the green is largely ruined from the standpoint of the game of golf. Unless the green is worked up and reseeded it is overrun during the following spring by weeds and coarse grasses.

Considerable experimental work was done at the Japanese beetle laboratory by J. J. Davis[2] using a solution of sodium cyanide in water as a control for the larvæ in turf. A satisfactory kill was obtained by this method and, according to his published results, the injury to grass was negligible. The writers' subsequent experience with this material corroborates the results secured by Davis as far as grub kill is concerned, but in our experience the material is decidedly toxic to the grasses of meadows and golf courses. It kills practically all of the fine grasses and clover in meadows and completely burns the fine grasses used on golf greens.

In connection with the above experiments the writers carried on tests in 1921 using a plain mixture of carbon disulfid in water, the mixture being maintained by agitation in a tank and run out through hose onto the turf. The grub kill by this method was not entirely satisfactory, but it was noted that no injury resulted to the grass; in fact, the material was *decidedly stimulating in its action.* Under these circumstances the work with cyanide was dropped and the experiments were confined to a thorough testing of carbon disulfid. It was found that a plain mixture of the material in water was unsatisfactory, due to the uneven dispersion of the carbon disulfid throughout the water even when agitated.

The writers therefore began a study of carbon disulfid emulsions, using various solutions of soaps as emulsifying agents. It was found that a fairly stable emulsion could be made with soaps in general, but the best emulsion from all standpoints was obtained by using resin-fish-oil soap as follows: Add 1 pound and 3 ounces of resin-fish-oil soap to 1 gallon of water and heat until dissolved; allow the solution to cool; place the solution in a churn or cream freezer and add 3 gallons of carbon disulfid; stir until the ingre-

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[1] Riverton Entomological Laboratory, Riverton, New Jersey.
[2] "Miscellaneous Soil Insecticides Tests," by J. J. Davis, in Soil Science, Vol. X, No. 1, July 1920, page 61.