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PROPER SPACING AND DEPTH OF TILE DRAINS

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The proper spacing and depth of tile lines has long been a perplexing problem. For many years the tile drainage systems were installed mostly with a certain spacing and depth because another successful system had been put in with such a spacing and depth. The irrigation engineers have already worked out relationships between soils and amounts of irrigation water to apply but the drainage engineers, with the exception of the German, have failed to find a satisfactory relationship between the soil and the rate of water movement through the soil.

The writer has developed a method of design of tile drainage systems based on soil characteristics and constants so simple, while at the same time effective, as to be readily applicable by the rural engineer.

SOIL PLASTICITY

The plastic consistency.—This consistency is to be recognized by the ability of the soil to be rolled out into a wire. The **lower plastic limit** is the wetness expressed as a per cent of the weight of the dry soil at which the soil can just barely be rolled into a wire under the fingers. At this lower limit when the size of the wire is about the same as that of a lead in a pencil, it will break into segments about ⅛ inch long.

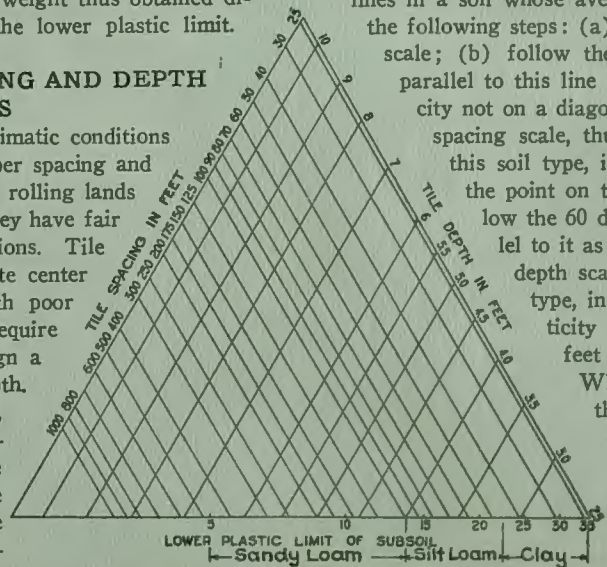
To obtain the lower plastic limit take about ½ pound of air dry soil and add water until the soil can be rolled out into a wire as before stated. If too much water is added, add more dry soil. When the proper moisture condition is reached, weigh the moist soil accurately, thoroly dry it in an oven at 215° F. and then weigh the dry soil. The difference in weight thus obtained divided by the weight of dry soil is the lower plastic limit.

FACTORS GOVERNING SPACING AND DEPTH OF TILE DRAINS

Type of soil, type of crop, and climatic conditions are the determining factors in the proper spacing and depth of tile lines. Usually the gently rolling lands do not present much of a problem as they have fair natural drainage except in the depressions. Tile lines should be run up the approximate center of these depressions. Flat lands with poor natural drainage are the ones which require a thoro investigation in order to design a system with the proper spacing and depth.

Doubtless, through a series of years, vigorous crops, especially the deep rooting types, tend to improve subdrainage conditions by a slight opening up of the subsoil, thus making it somewhat more responsive to tile drainage. However, the chief influence of crops upon proper design of tile drainage systems is the fact that different types of plants vary widely both in their normal rooting depths and in their tolerance for excess water in the soil; hence subdrainage does not have to be as effective for the shallower rooting or for the more water resistant as it does for the deeper rooting crop types or those more sensitive to excess water in the soil.

In order for the water to get to the tile lines, there must be lateral as well as vertical movement. This lateral movement is caused by the "head" of water from the tile line to the mid-point between tile lines. Under average conditions the spacing of the tile lines should be such that the maximum "head" of water would be at least one foot below the surface and lowered from this point through the next foot of depth at a rate of 9 inches per day. Since the gravity water moves with any degree of rapidity only through the non-capillary or large pores, the larger the pores the more rapid the movement of the water. Therefore the spacing and depth of any tile system is directly related to the non-capillary pore space of the soil. But, as the pore space is directly related to the soil plasticity, therefore, the spacing and depth of the tile lines is also directly related to the soil plasticity which is determined much more easily than the pore space. This direct relationship of the tile spacing and depth to the soil plasticity was worked out for practical cases as shown in the figure.



Additional copies of the figure may be obtained by writing Division of Agricultural Engineering, University Farm, St. Paul, Minnesota.

Examples Illustrating the Use of the Figure

If it is desired to determine the proper spacing and depth of tile lines in a soil whose average plasticity is known, say 14, take the following steps: (a) locate the plasticity on the horizontal scale; (b) follow the 60 degree diagonal line to left (or parallel to this line in case of some other value of plasticity not on a diagonal line) to the intersection of the tile spacing scale, thus getting the proper tile spacing for this soil type, in this case about 100 feet; (c) from the point on the plasticity scale located in (a), follow the 60 degree diagonal line to right (or parallel to it as in (b)) to the intersection of the tile depth scale, thus getting the depth for this soil type, in this case about 4.0 feet. If the plasticity is 25, the spacing should be about 40 feet and the depth 3.0 feet.

Where outlet conditions are poor and the proper depth can not be obtained, the spacing should be for the plasticity corresponding to the depth obtainable. If, in the first case mentioned, the maximum depth obtainable was 3.5 feet, which corresponds to a plasticity of 18, the spacing should be about 65 feet instead of 100 feet.

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