DRAINAGE AND THE USE OF CLAY TILES

by A. L. TURNER

Land drainage is a very expensive business—it is worth while being particular about the details because the work is buried and out of sight and things that go wrong cause much additional expense and trouble. So I make no apology for commenting upon some matters which may appear trivial, viz. the gap between pipes and the " porosity " of land drains.

The gap between 12 *in. lengths of agricultural land-tile-drain-pipes when laid as lateral drains.* This has been the subject of a number of scientific studies and some of these are:—

" The Hydraulic Comparison of Land Drains and the Determination of Effective Diameters " by A. N. Ede in the Journal of Agricultural Engineering Research Vol. 3. No. 1—1958. Among other things this examined the " relative discharge data for variously gapped, spaced and perforated drains ".

As to the effectiveness of drains laid with varying gaps he says " The gap width is only of material significance below widths of 1/20 in.; a tenfold increase to a gap of ½ in. leads only to a 10% increase in discharge," and he concludes " the size of the gaps between drains of normal length or longer has very little influence on performance and any gap of 1/20 in. is relatively good. For drains of ordinary roughness this infers, in effect, a butt joint." You will note the qualification " of ordinary roughness "—there may be tiles on the market which have been burnt so well and are so accurately manufactured as to produce almost a watertight butt joint, but these, I suspect, are unusual and conditions for getting a " perfect " joint in the ground would also be uncommon.

" Potential Flow into Circumferential Openings in Drain Tubes " by Don Kirkham, Journal of Applied Physics No. 21, 1950.

This paper gives a theoretical analysis of the effect of the spaces between drain tube units as used in artificial drainage of soils. The basic problem solved is that for axially symmetric flow from an external cylindrical boundary at constant potential to a series of equal, equally spaced openings at a lower potential, all located axially on, and comprising a part of, the otherwise impermeable drain tube. The analysis shows, for example, in the case of 6 in. diameter drain tubes having 1 ft. long impermeable sections and buried 4 ft. deep in uniformally permeable soil, that increasing the openings from 1/32 in. width to ¼ in. will increase the flow 36%, while embedding the tubes in gravel to make the 1/32 in. openings of effectively infinite width will increase the flow 180%. The discussion in this paper further considers the effect of differences between widths of 1/64 in. to as much as ¼ in. and concludes that if the tubes are embedded in gravel the open spaces become effectively infinite—this is a consequence of the negligible loss of lead which results when water seeps through gravel as compared with water seeping through soil.

" Drainage of Agricultural Lands " in the Section on Subsurface Drains by G.O. Schwabe, 1957.

Mr Schwabe concludes that for practical purposes data shows that doubling the crack width will increase the flow of approximately 10% and that for a ⅛ in. crack width 50% of the total lead is dissipated within 1 in. of the crack opening; this effect indicates that permeability of the soil and shape of the soil near the crack will greatly influence the flow. Tests on crack width of ⅜ in.-⅛ in. and close (1/32 in.) and ⅛ in. with gravel envelope indicated that ⅜ in. gap was too wide, resulting

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in a considerable inflow of soil. Drains with gravel envelopes were more effective in keeping out soil. He recommends ⅛ in. to ¼ in. in stable soils and as close as possible in unstable soils. I would interpret these soils as heavy clay in the former and silts and sands in the latter.

It should be noted that tile drains laid automatically by machinery are invariably laid with close butt joints—the pipes touch each other; vast improvements of water intake occur when gravel surrounds the gaps in the drain, in heavy (clay) land tight butting is less critical than in silt on sandy land.

This is summed up in "Soil and Water Conservation Engineering", page 313: "It is important in laying tile to leave as large a crack width as is permissible as limited by the stability of the soil material." In case of doubt, butt tight.

Generally for average pipes butt joints will in effect leave an opening of about 1/20 in. which is adequate.

Questions have been raised, and in my opinion incorrectly answered, in connection with the "permeability" of tiles. The following comments may be of use. The qualities required of a tile are: (a) high strength (tested as in BSS.1196); (b) low absorption (of water); (c) high resistance to the action of frost; (d) accuracy as to length, cross section, shape, etc.—(these are tested as in BSS.1196).

The burning process by which clay tiles are made approximates to that of brick making. When very high temperatures are reached and when dense clays are used the result is towards complete vitrification—or fusing of the materials. Such tiles are virtually impermeable—that is no water in measurable quantities passes through the sides of the pipe at all. Pipes made of sandy clays, and if imperfectly burnt, will have high absorption and some permeability—and may well be much less frost resistant.

Tiles can be tested for absorption by standing them in a container of water having first placed some plastic or clay waterproof material in the base of the container—a dry tile is then stood on end on this and made watertight at the base. After filling the container and leaving for 48 hours or so, if there is any uptake of water over about 12-15% of the weight of the tile the absorption is high and if water freely passes through the tile is likely to have low strength and be defective. Frost resistance often follows inversely the water absorption trend.

It is essential to distinguish between land drains made of porous concrete and those made of clay (tiles). The former are indeed intended to permit water to pass through the wall of the pipe—tests for this are prescribed in BSS.1194. This is achieved by making them of an aggregate which is not dense and from which most of the fines have been eliminated. (Readers may know of course that tarmacadam tennis courts are designed on the same principles.) Pipes of this sort are called "permeable wall" pipes.

In the literature on design of tile drain systems, nowhere can I find any suggestion that clay tiles *should* be porous—and therefore the comment by the consultant editor on page 36 of No. 6, Vol. 23 of "The Groundsman" must be regarded in my opinion as completely misleading. In good, sound, well-burnt clay tiles water will not penetrate through the "pores of the pipe" in any significant quantities. Pipes salvaged and covered in soil can be reused with every confidence—they should be cleaned off internally and externally and can be as good as new.

It is worthwhile to note as a summary of the discussion above the role of the new plastic drain tubes; both factors are involved—perviousness and gap. These tubes are made of completely impervious material with slots 1.19 mm. wide (about 1/20 of an inch).