COVER MATERIALS FOR TILE DRAINS

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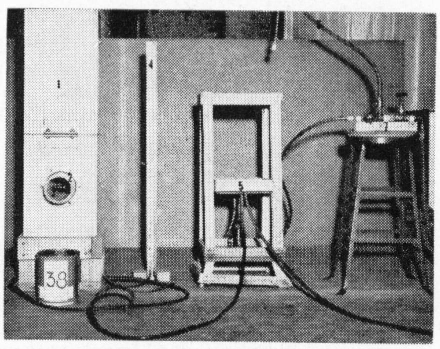
Silting of tile drains has been considered by many drainage engineers to be one of the most serious problems connected with tile drainage of sandy soils. In Ontario there are many acres of poorly-drained sandy soils which have become highly productive in response to tile drainage. However, the life of the drainage system is usually short unless special protective measures are taken to exclude the entrance of sand yet allow water movement into the drains. Common practices for this purpose have been to wrap the upper half or two-thirds of the tile joint with tar paper, or to blind the drain with straw, sawdust, shavings or other organic materials. Variable success has been experienced using these methods.

Recently two comparatively inexpensive glass fibre cover materials – Duramat (manufactured by Globe Glass Saturaters Ltd., Petrolia, Ontario) and Tileguard (manufactured by L. O. F. Glass Fibers Co., Toledo, Ohio, U.S.A.) have become available commercially. Tileguard is a glass fibre mat consisting of multiple layers of glass fibres in jack-straw arrangement held together with a phenol-formaldehyde binder. The mat is random-reinforced by swirls of reinforcing yarn and is an average thickness of 0.020 inches. The glass is a lime-borosilicate type. Duramat is a bituminous-coated, parallel yarn reinforced glass fibre mat. The surface is dusted with inert material to prevent sticking in the roll and the mat has limited porosity. The nominal thickness is 0.033 ± 0.003 inches. Sisson (3) reported that these materials have been recommended for use by several States in the United States. However, limited investigational work on their effectiveness has been performed. In 1959, Overholt (2) found in a laboratory study that a glass fibre filter material was effective in reducing the rate of siltation and in increasing the flow rate into a tile drain. Glass fibre wrapped completely around the tile joint gave almost complete protection and was more effective than glass fibre wrapped over the top three-quarters of the tile joint. Sisson's (3) comparative study of seven cover materials showed that a combination of glass fibre above and plastic below was one of the best protective materials. The performance of two types of glass fibre materials for use as drain filters was evaluated by Nelson (1). Tileguard Type S-110 with random-reinforcing was found to be satisfactory, and a criterion was established by which it can be determined whether a drain in a given soil would be adequately protected by this filter material.

The purpose of this paper is to report on a study of the performance of Tileguard and Duramat, used singly and in combination with each other, as cover materials for tile drains.

MATERIALS AND PROCEDURE

Five different cover material treatments were studied in the laboratory. The five treatments studied were "blinding with topsoil" (check), "Tileguard above the drain", "Tileguard above and below the drain", "Duramat above the drain", and "Tileguard above – Duramat below the drain". The experimental apparatus (Fig. 1) was designed to simulate field conditions around one tile joint. Granby sandy loam subsoil was packed uniformly into the bottom of a metal tile box 12 inches square by 39 inches high at approximately the field bulk density. The subsoil was scraped to the shape of a trencher shoe bottom. Two 4-inch diameter asbestos-cement tile were placed in the simulated trench bottom so that the two outer ends protruded through holes in each side of the tile box. The tile joint spacing inside the box was adjusted to ⅛ inch and the tile were clamped to guard against displacement during the backfill operation. The cover material treatment



1. Tile box
2. Tile
3. Clamp
4. Manometer
5. Constant-head tank
6. Height adjustment screw
7. Control valve
8. Connection to Rainfall Simulator

Figure 1. General View of Apparatus Assembly

was placed around the tile and the rest of the box was filled with subsoil and compressed at a pressure of 1,000 lbs. A low rate of rainfall onto the soil was simulated and continued until ground-water flow conditions were established around the drain. The rainfall was stopped and ground-water flow into the drain was maintained by means of a constant-head tank connected to inlets at the bottom of the box. With the assistance of manometers connected to wells inside the box, water table conditions were kept uniform for all treatments by adjusting the height of the constant-head tank. This method of applying water was chosen in order to simulate a common field condition where rainfall continues until a water table in the soil is established. The water discharged and the soil moved into the drain were measured by taking samples over successive 15-minute periods for six hours. By using this sampling technique, studies of variations in flow and soil movement during the test period could be determined. Mechanical analyses were made on the soil moved into the drain under each treatment. All treatments were randomized and replicated four times, and all results were analyzed statistically.

RESULTS AND DISCUSSION

Flow of Water

The differences in accumulative flow of water between treatments is shown in Figure 2. There was no significant difference between the total quantity of flow for the "Tileguard above and below" treatment and the "Tileguard" above – "Duramat below" treatment. Differences in flow between all other treatments were significant. Examination of the flow curves showed that the discharge rate during the initial period was considerably higher than the final rate. This increased rate continued for approximately two hours after which the discharge rate became almost constant. This indicates that the drainage of gravitational water derived from the simulated rainfall persisted during this initial two-hour period and contributed water in excess of that being supplid by the simulated ground-water flow system. The constant discharge rate towards the end of the test period was due to the effect of ground-water flow conditions. A statistical analysis of the average discharge rates during the final two-hour period gave the same results as the analysis of the total quantity of flow data.

Soil Movement

Figure 3 shows the quantity of soil moved into the drain under each treatment. There was no significant difference in the quantity of soil between "blinding with topsoil" and

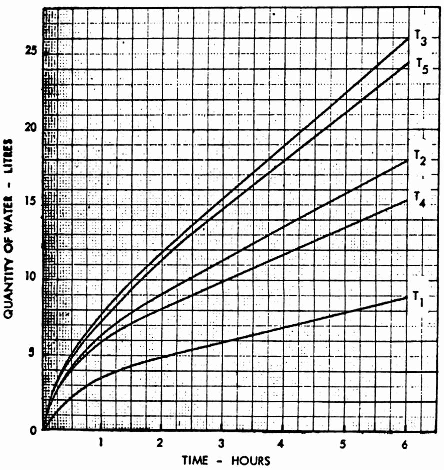


Figure 2. Accumulative flow curves for different treatments.

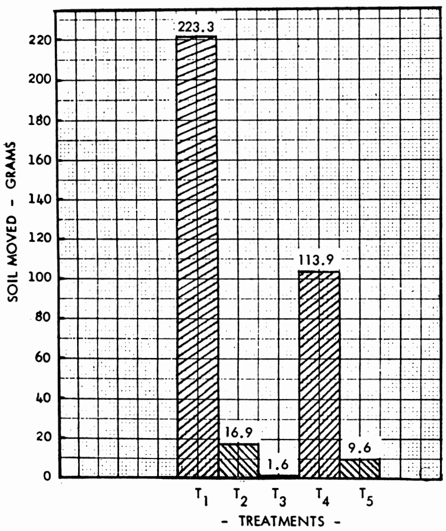


Figure 3. Soil moved into the drain under different treatments.

—Key for Fig. 2 and 3—

T_1—Blinding with Topsoil

T_2—Tileguard above

T_3—Tileguard above and below

T_4—Duramat above

T_5—Tileguard above, Duramat below

"Duramat above" treatments, nor between "Tileguard above" and "Tileguard above—Duramat below" treatments. Differences in soil movement between all other treatments were significant. Careful examination of conditions around the tile made at the end of each test revealed that there was evidence of soil movement through the junction of the lower and upper layers of Tileguard under this treatment. Soil movement into the drain also occurred at the junction of the lower and upper layers in the "Tileguard above—Duramat below" treatment. These observations indicate that wider strips of Tileguard should be used on top. It was also observed that under the "Tileguard above—Duramat below" treatment the groove in the simulated trench bottom was completely damaged and loose soil was present in the groove. This resulted in the slackening of the Duramat from the tile which, in the field, may lead to misalignment of tiles. Under the "blinding with topsoil" treatment, about four percent of the total soil moved into the drain entered through the crack space during the blinding process.

Under every treatment, all of the soil movement occurred during the first hour of the test period when the flow of water into the drain was due to the downward movement of gravitational water from the soil above the drain plus equilibrium ground-water flow conditions. This observation emphasizes that in the field soil movement will occur during and shortly after a rainfall rather than solely under equilibrium ground-water flow conditions.

Significant changes in the composition of the original soil and the soil moved into the drain occurred only

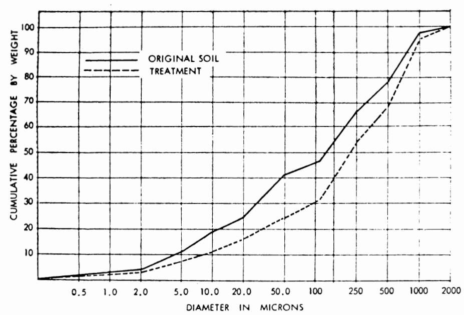


Figure 4. Composition of the Original Soil and the Soil Moved Into the Drain (Blinding with Topsoil Treatment).

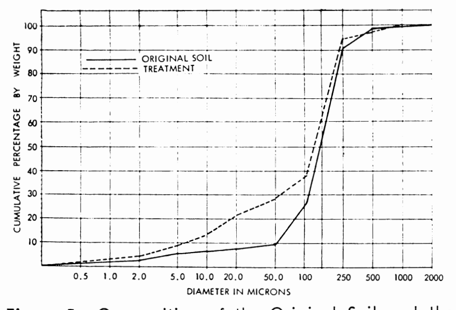


Figure 5. Composition of the Original Soil and the Soil Moved Into the Drain (Tileguard Above and Below Treatment).

under "blinding with topsoil" and "Tileguard above and below" treatments. The composition of each soil is shown graphically in Figures 4 and 5. There was a significant increase of 29 percent in the sand fraction and a decrease of 40.2 percent in the silt and clay fractions under the "blinding with topsoil" treatment. It is apparent that some subsoil as well as topsoil was carried into th drain. In the "Tileguard above and below" treatment there was a significant increase of 185-1 percent in the silt and clay content over the original soil composition. The increase in fine particles is explained by the fact that the crack was covered almost completely by an effective filter material. The coarser particles that did enter the drain probably passed through the junction of the lower and upper layers of Tileguard.

SUMMARY

Five cover material treatments were compared to determine their effect on the movement of soil and water through the tile joint into the drain. The experiment was designed to simulate field conditions around one tile joint as closely as possible.

Based on their performance, the treatments can be rated in the following order:

1. Tileguard above and below
2. Tileguard above—Duramat below
3. Tileguard above
4. Duramat above
5. Blinding with topsoil.

It was observed that soil movement into the drain occurred due to gravitational water flowing from the backfill material above the drain and the ground-water flow conditions had comparatively little effect on soil movement.

The results of this study suggest that further research should be conducted on treatments using wider strips of cover material above the drain. They also indicate that the effect of more cycles of alternate rainfall and ground-water flow on soil and water movement should be studied.

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