CORRUGATED ARCHED DRAINAGE TILE

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This drainage tile for the collection and disbursement of liquids is in the shape of an elongated tube made from a polymeric material such as polyethylene, polypropylene, etc. The tube has a slightly convex base in order to conform to the trench in which it rests. Sidewalls are connected to and arched upwardly and inwardly from the base to an apex where they join in a continuous curve. The sides and base are corrugated to provide greater resistance to compressive forces while permitting flexing and bending of the tube about its longitudinal axis.

11 Claims, 6 Drawing Figures
CORRUGATED ARCHED DRAINAGE TILE

BACKGROUND OF THE INVENTION

It is desirable to remove excess water, surface or sub-surface in fields which are used for agricultural purposes, in order to prevent damage to crops, improve the condition of the soil and permit earlier entrance onto fields after rainfall. Similar problems of water drainage are common to commercial and residential establishments. The conventional drainage solution is to provide a trench in which drainage tiles are placed. Normally, the trenches are dug by a trench digging machine with a digging wheel. Some machines employ a traveling chain but the wheel is more prevalent. The digging wheel has a multitude of shovels around its perimeter which continuously scoop up the soil. The resultant trench is commonly 10 to 12 inches wide and has a bottom which is generally flat but may be slightly rounded or concave. The exact shape of the bottom of the trench is determined by the profile of the digging shovels.

Many problems are encountered in laying and maintaining conventional drainage tile in the trench. Improper foundations, misalignment and breakage of the tiles are the major causes of decreased capacity or inoperability of the drainage system. Present drainage tile are normally clay pipes having circular cross-sections, and measuring approximately 12 inches long. A slight separation is maintained between the drainage tiles in the trench in order to allow the water from the soil to enter the system for transmission to its ultimate destination. However, because the round drainage tile is positioned on the relatively flat bottom of the trench, there are difficulties in establishing an adequate foundation to fully support the tile over its entire underside.

As soil is placed upon the drain tile from a vertical direction, there will be voids or open spaces below the center line of the tile. Over an extended period of time, the soil will eventually fill the voids and completely support the bottom of the tile. However, during the substantial period of time that it takes to fill these voids, the lower half of the tile is supported on only a fraction of its lower surface. When large farm machinery or other heavy loads are subsequently placed on the soil above the inadequately supported drainage tile, unusually high compressive stresses may result. Such stress may fracture the relatively brittle clay tile. The broken tile allows soil to enter the drainage system and at best decreases its capacity.

Until the soil fills in the void underneath the round tile, there may also be a subsequent shifting and misalignment of the tiles. The round tiles on the relatively flat trench bottoms are somewhat mobile and may move out of alignment with one another. Such difficulties in alignment may result in excessive soil falling between the drainage tiles, thus clogging or severely hampering the capacity of the drainage system.

In order to correct the problem of alignment of the conventional round drainage tile, it has been proposed to dig a small channel in the center of the trench one to two inches wide. In this manner, the drainage tile, which have a radius several times the width of the channel in the trench, may be easily aligned. The drainage tile will, in effect, sit along the uppermost edges of the small channel. However, this linear support concentrates any forces placed on the drainage tile and amplifies the stress and breakage problem from inadequate support.

Freezing and subsequent expansion of the soil may also place large compressive forces on the drainage tile. A brittle material such as clay will simply fracture while the forces reach a certain magnitude. Again, soil penetration will disrupt the drainage system. The rigidity of ceramic tile also requires special fittings such as elbows, etc.

In drainage systems of a relatively large size, the heavy ceramic tiles cannot be manipulated by an individual. Heavy machinery and the resulting cost is thus required to establish the drainage system. Further, the unit weight of clay tile is very high and, therefore, the costs of handling, shipping, installation, etc. are relatively high.

If round drainage tile are made of plastic or some other non-rigid material, it could still collapse if inadequately supported with the resulting reduction in the efficiency of the drainage system. Moreover, during the period in which the void underneath the round drainage tile was being filled, the tiles could be moved out of alignment with each other, thus causing soil to enter the system.

It would be highly advantageous to have a drainage tile which is flexible, strong, light, fully supported in a standard trench, easily installed and resistant to shifting.

The drainage tile of this invention fulfills these criteria. This drainage tile is a corrugated plastic tube having a roughly triangular cross-section. The base of the drainage tile is relatively flat but is preferably slightly convex to provide a maximum amount of contact with the slightly concave bottom surface of the trench. This shape of the base effectively eliminates misalignment due to shifting and other problems which result when a circular tile is not fully supported from its underside. Curved sides extend upwardly and inwardly until they meet at a curved apex to form an arch. The arch configuration is recognized for its structural strength and stability. Additionally, the corrugations add strength to the tubing while permitting it to bend and flex without breaking. Thus, any loads applied through heavy machinery or the like passing over the trench after it has been filled would not cause the tile to collapse or rupture.

Because of the plastic material's light weight, the tile may be shipped with a significant savings in transportation expenses. Moreover, a plastic material such as polyethylene or polypropylene when corrugated is relatively flexible which allows it to bend and thus negotiate curves without the use of elbows or other expensive fittings. The ease in handling and installation also makes the light plastic tubing extremely desirable for the small contractor or residential user.

Since clay tile does not have the advantage of effective deflection, it must have an extremely high load-bearing strength. Presently, clay tile are constructed to withstand approximately 1,000 pounds per lineal foot. Since plastic drain tile will deflect very noticeably without harmful effects to thereby provide a full or continuous support along the length thereof, the effective load-bearing strength of the plastic tile is greatly increased per unit of material. The actual strength of the tile will be determined by the wall thickness, tube
dimensions, the corrugation design, and the material used. Well known polymers such as polyethylene, polypropylene, polyvinyl chloride, etc. may be used.

The present invention proposes that the corrugations, as used in conjunction with a generally arch shaped section of the tube, have a minor diameter section or root and major diameter section or crest connected by a corrugation wall. Openings for ingress of water are preferably placed in the corrugation wall near the neutral axis. In this manner, the maximum structural integrity of the tile is maintained. It is anticipated, however, that the openings may be placed elsewhere on the tube, such as in the root of the corrugations.

**SUMMARY OF THE INVENTION**

This invention relates to a drainage tile comprising a polymeric corrugated elongated tube having a curved base which is relatively flat. Curved sides are joined to the base and extend upwardly and converge to form an arch. The sides and base are corrugated to provide an optimum strength to weight ratio and maximum resistance to compressive forces while permitting flexing and bending of the tube.

FIG. 1 is a perspective view of a typical trench partially cut away in which the drainage tile of the invention rests;

FIG. 2 is a side view of the corrugated drain tile of this invention, showing the openings for the entrance of water placed in the root of the corrugations;

FIG. 3 is a sectional taken through line 3—3 of FIG. 2 and illustrates a cross-sectional view of this invention;

FIG. 4 is a sectional taken through line 4—4 of FIG. 2 and illustrates the corrugations positioned in the root of the corrugations;

FIG. 5 is a cross-sectional view showing an alternate embodiment of this invention in which the openings are placed in the walls of the corrugations, preferably at the neutral axis;

FIG. 6 is a sectional taken through line 6—6 of FIG. 5 and illustrates the openings positioned in the walls of the corrugations.

As illustrated in FIG. 1, the drainage tile 10 lies in a trench 12 having a bottom 13 with sides 14 and 15. The trench 12 is normally dug by a trenching machine. The sides 14 and 15 are generally vertical and the bottom 13 is relatively flat. However, the bottom 13 does have a slight curvature because of the curvature of the outer portion of the shoes which are normally used in digging the trench.

The drainage tile 10, as noted in FIGS. 1, 2 and 4 has corrugations 16 which are made of lower sections or roots 18 and higher portions or crests 20 which are connected by upwardly and inwardly tapered corrugation walls 22.

A base 24 of the drainage tile 10 is substantially flat but slightly convex in order to conform to the bottom 13 of the trench 12.

It will be noted that the height or depth of the corrugation walls at the extremities of the bottom portion is less than the height or depth of the walls of corrugations in the central sections. While this particular feature is not critical nor necessary to the functional features of the invention, it is preferred for the reason that the stress upon the tile will be greater in the central section of the bottom than at the extremities.

It will also be noted that the height (or depth) of the corrugations at the lower portions of the sidewalls forming the arch is greater than the depth of the corrugations in the upper sections of the converging sidewalls. This relationship between the profile of the tile and the depth or height of the corrugations provides maximum strength per unit of material used. It should be understood that this particular relationship is not critical but is preferred as an optimum design.

Sides 25 and 26 curve upwardly and converge until they meet at an apex 28 to form a continuous arch generally indicated at 29. The apex 28 is normally rounded and in the form of a continuous curve rather than a point in order to distribute the forces evenly over more surface area. This curve reduces the possibility of any fracture due to the concentration of forces at a point.

The corners 30 and 32 formed by the joining of the sides 25 and 26 with the extremities of the base 24 have a relatively small radius of curvature compared to the radius of curvature at the apex 28 of the arch 29. As a specific example, if the drainage tile of this invention were about 4 1/4 inches high, the bottom corners could have a radius of about one-sixteenth inch while the radius of the curvature of the arch at the root would be about 1 inch and at the crest, it would be 1 3/16 inches. In this respect, a typical preferred embodiment would use about a 5 1/4 inch radius of curvature for the root and about a 5 1/2 inch radius for the crest. In this example, the root of the corrugations in the base would utilize about an 11 1/4 inch radius of curvature whereas the crest of the corrugations in the base would have a 7 5/8 inch radius.

Openings 34, as shown in FIGS. 2 and 4, are placed in the roots 18 of the corrugations 16 to allow water to enter the drainage tile. As illustrated, there are a number of openings radially positioned about the periphery of the drainage tile. The positioning and number of openings 34 will depend upon their size, the size of the drainage tile, etc.

As illustrated in FIGS. 5 and 6, an alternate embodiment of the drainage tile 36 has openings 38 for water ingress in the corrugation wall 40 rather than in the root 42. In every other respect, however, the embodiment in FIG. 5 is identical to that shown in FIGS. 1—4. The placement of the openings 38 in the corrugation wall 40 of the corrugation has a particular advantage.

It will be recognized that openings or perforations through either the crest or the root will weaken the compressive strength of the corrugated tile much in the nature of a hole of relatively large size and would weaken an I-beam if located in either or both of the flanges. In analyzing applicant's corrugated tubing structure, the crest and root portions function much in the nature of the flanges of an I-beam with the wall portion which joins the root and the crest serving as the web of the I-beam. Accordingly, it is preferred, for structural reasons, to locate the perforations in proximity to the mid portion of the wall joining the root and crest of the corrugation. From the standpoint of stress analysis, such a positioning is quite like placing an opening at the neutral axis of an I-beam. It will be understood that this positioning minimizes the effect upon the structural integrity of the member.

Again, with a view of providing maximum strength with the least amount of material, it is preferred to pro-
portion the root and crest of the corrugations so that
the respective cross-sections are of nearly equal area.
In certain cases, the lineal dimension of the crest may
be greater than that of the root. In such a case, the
thickness of the crest would be less in order to achieve
the condition of equal cross-sectional areas. Further, it
is preferred to maintain the wall portions of the corru-
gations at a minimum angle with respect to the lon-
titudinal axis of the tile. An optimum design would dictate
that the plane defined by the walls be angled slightly
with respect to a line perpendicular to the axis of the
tubing. Otherwise, it would be difficult to release the
tubing from the die in which it is formed.

It is contemplated that the drain tile of this invention
would be supplied to the user either in sections of suit-
able length or as "continuous" lengths wound upon
spools.

1 claim:
1. A drainage tile for collection and disbursement of
liquids comprising:
a seamless, elongated flexible tube of polymeric
material;
said tube having a relatively flat base on which it
rests when placed in a trench;
sides connecting to and arching upwardly from the
base to an apex where they are joined;
the sides and base having continuous circumferential
corrugations to enhance resistance to compressive
forces while permitting flexing and bending of the
tube relative to its longitudinal axis, said corru-
gations comprising root sections and crest sections
which are joined by wall sections, the depth of the
corrugation in the sides being greater at the base
than at the curved apex, and openings in the wall
sections of the corrugations to permit ingress and
egress of liquid.

2. The drainage tile of claim 1 wherein the base is
connected to the lower end of the sides to form a
corner having a small radius of curvature relative to the
radius of the curvature of the arc at its apex.

3. The drainage tile of claim 1 wherein the polymeric
material from which the tube is formed is polyethylene.

4. The drainage tile of claim 1 wherein the polymeric
material from which the tube is formed is polyvinyl
chloride.

5. The drainage tile of claim 1 wherein the base is
slightly convex to fit the curvature of the trench in
which it is placed.

6. The drainage tile of claim 1 wherein the cross-sec-
tional area of the crest of the corrugations are approxi-
mately equal to the cross-sectional area of the roots
thereof.

7. The drainage tile of claim 1 wherein the relatively
flat bottom is slightly convex.

8. A drainage tile for collection and disbursement of
liquids comprising:
an elongated tube of polymeric material;
said tube having a relatively flat base on which it
rests when placed in a trench;
sides connecting to and arching upwardly from the
base to an apex where they join in a continuous
curve;
the sides and base having corrugations to enhance re-
sistance to compressive forces while permitting
flexing and bending of the tube, openings in said
tube to permit ingress of liquid, the depth of the
corrugations on the sides being greater at the base
than at the curved apex.

9. The drainage tile of claim 8 wherein the depth of
the corrugations at the center of the relatively flat bot-
tom is greater than at the juncture with the sides.

10. The drainage tile of claim 8 wherein the openings
are in the side walls of the corrugations.

11. The drainage tile of claim 8 wherein the base is
connected to the lower end of the sides to form a
corner having a small radius of curvature relative to the
radius of the curvature of the arc at its apex.

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