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(54) **DRAINAGE STRUCTURE**

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## Description

**[0001]** The present invention relates to a structure for draining surface water, a method for draining surface water and a method of installing a structure for draining surface water.

**[0002]** Precipitation such as rain, snow, sleet, hail and the like results in surface water which can cause the ground to become waterlogged. It is important to drain surface water to prevent damage to the ground caused by excess water. This is a particular issue for recreation grounds, including children's playgrounds and sports grounds where there is a high level of wear on the ground. If the ground becomes waterlogged, the surface can become damaged by the high level of wear, and then needs repair or replacement. It is therefore important that the ground is provided with an efficient drainage system.

**[0003]** NL1013987 discloses a subsurface comprising stone wool granulate for a sports field which is at least partly covered in natural grass. The purpose of the stone wool granulate is to stabilise the ground and improve the flatness of the sports field even when the grass is played on excessively. It is necessary to provide drainage lines in addition to the stone wool granulate in order to provide adequate drainage.

**[0004]** FR2877956 discloses a layered structure for a children's play area which has improved properties for cushioning falls. The structure comprises a layer or mat of grass, a layer of earth and a layer of mineral fibres bound by a binding agent and comprising a wetting agent. The wetting agent is present to allow the mineral fibre panels to absorb water to help the grass to grow. The wetting agent is designed to wash out over time so that the mineral fibre panels gradually lose their water retention capacity. There is no consideration of the importance of draining water from the children's play area.

**[0005]** It is known to provide drainage lines under recreation grounds such as football pitches in order to drain surface water to a water disposal point. It is also known to use a drainpipe that is provided with apertures, surrounded by gravel, beneath the surface as a drainage line. The main purpose of the gravel is to create an area around the drainpipe where water can run relatively freely towards the drainpipe, since the capacity of the gravel to hold water is limited by the available space between the particles of gravel. Often a geo-textile is wrapped around the drainpipe in order to prevent soil from entering the drainpipe through its apertures. This drainage system is often insufficient and requires secondary drainage systems in order to manage the volume of surface water. Secondary drainage systems include slitting of the ground to install trenches of sand. This system requires regular maintenance with frequent sand dressing to maintain the safety and quality of the surface. This system is costly to install and maintain as excavations are expensive and involve the removal of a large area of ground and replacing the area with the required materials.

**[0006]** US4019,326 discloses a horizontal soil drainage system consisting of a non-woven three-dimensional mat of a plurality of looped, intersecting and substantially amorphous filaments of melt-spun synthetic polymers bonded together at their intersections, at least one of the outer surfaces of said mat having a lower cross-sectional porosity than the center zone of said mat. This mat can be rolled up and therefore does not have a high compressive strength and may be compacted by force impacting from the ground surface. This will reduce the porosity of the mat, and thus the ability of the mat to drain water.

**[0007]** WO 2008/128156 A1 discloses a water channeling system including at least one channeling member comprising fixed aggregate forming a solid body. The at least one channeling member has a first end, a second end, and a plurality of fluidly connecting interstices therewithin. In this version, the at least one channeling member is water permeable longitudinally between the first and the second end. The at least one channeling member may be installed below ground to channel water from a first location to a second location.

**[0008]** There is a need for a structure for draining water that can be easily installed. There is a need for a structure that is easy to maintain. There is a need for a structure which prolongs the usability of the surface and a structure which can convey water to a disposal means. There is a need for a drain that can absorb water from the ground and store the water until it can be dissipated back to the ground. Further there is a need for a structure that does not become contaminated with earth from the ground and which can be installed without being wrapped in a geotextile material. Further there is a need for a structure which has a buffering capacity to hold water as well as a capacity to convey water. There is a need to produce such a structure which is environmentally acceptable and economical in terms of production, installation and use. The present invention solves these problems.

### Summary of Invention

**[0009]** In a first aspect of the invention, there is provided a structure for draining surface water, comprising a coherent force distribution layer (1) and a drain layer, wherein the drain layer is below the force distribution layer, characterised in that the drain layer is formed of an array of coherent man-made vitreous fiber (MMVF) drain elements (2), wherein each of the drain elements comprises man-made vitreous fibres bonded with a cured binder composition; wherein each of the drain elements has opposed first and second ends and a passage (3a) which extends from a first opening in the first end to a second opening in the second end; wherein the MMVF drain elements comprise a hydrophilic binder and/or a wetting agent and wherein the force distribution layer comprises a continuous plastic layer, a continuous rubber layer, or a coherent MMVF layer.

In a second aspect of the invention, there is provided a

method of installing a structure for draining surface water, the method comprising positioning a drain layer in the ground, wherein the drain layer is formed of an array of coherent man-made vitreous fiber (MMVF) drain elements, wherein each of the drain elements comprises man-made vitreous fibres bonded with a cured binder composition, and positioning a coherent force distribution layer above the drain layer, wherein each of the drain elements has opposed first and second ends and a passage (3a) which extends from a first opening in the first end to a second opening in the second end, wherein the first opening of the drain is arranged in fluid communication with a water disposal point; wherein the MMVF drain element comprise a hydrophilic binder and/or a wetting agent and wherein the force distribution layer comprises a continuous plastic layer, a continuous rubber layer, or a coherent MMVF layer.

**[0010]** In a third aspect of the invention, there is provided a method of draining surface water, the method comprising providing a coherent force distribution layer and a drain layer, wherein the drain layer is formed of an array of coherent man-made vitreous fiber (MMVF) drain elements, wherein each of the drain elements comprises man-made vitreous fibres bonded with a cured binder composition, wherein the drain layer is below the force distribution layer, whereby water in fluid communication with the drain elements is: (i) absorbed by the MMVF substrate, and/or (ii) conveyed along the drain elements, wherein each of the drain elements has opposed first and second ends and a passage (3a) which extends from a first opening in the first end to a second opening in the second end, whereby water in fluid communication with the first drain is: (i) absorbed by the MMVF substrate, and/or (ii) conveyed along the passage; wherein the MMVF drain element comprise a hydrophilic binder and/or a wetting agent and wherein the force distribution layer comprises a continuous plastic layer, a continuous rubber layer, or a coherent MMVF layer.

Detailed description of the invention

**[0011]** The invention relates to draining surface water, preferably draining surface water from recreation grounds such as children's playgrounds and sports grounds, preferably sports grounds. Sports grounds include football pitches, rugby pitches, cricket pitches, lawn bowling greens, lawn tennis courts, golf greens, playing fields, athletic grounds and equestrian centres. This invention is particularly useful for draining surface water from football pitches.

**[0012]** MMVF substrates are known for numerous purposes, including for sound and thermal insulation, fire protection and in the field of growing plants. When used for growing plants, the MMVF substrate absorbs water to allow plants to grow. When used for growing plants, it is important that the MMVF substrate does not dry out. In the field of growing plants, an MMVF substrate is normally used instead of soil to grow plants. The relative capillarity of soil and an MMVF substrate is not important in the field of growing plants. WO01/23681 discloses the use of MMVF substrate as a sewage filter.

**[0013]** The man-made vitreous fibres (MMVF) can be glass fibres, ceramic fibres, basalt fibres, slag wool, stone wool and others, but are usually stone wool fibres. Stone wool generally has a content of iron oxide at least 3% and content of alkaline earth metals (calcium oxide and magnesium oxide) from 10 to 40 %, along with the other usual oxide constituents of MMVF. These are silica; alumina; alkali metals (sodium oxide and potassium oxide) which are usually present in low amounts; and can also include titania and other minor oxides.

**[0014]** Fibre diameter is often in the range of 3 to 20 μm, preferably 3 to 5 μm.

**[0015]** The MMVF substrate is in the form of a coherent mass. That is, the MMVF substrate is generally a coherent matrix of MMVF fibres, which has been produced as such, but can also be formed by granulating a slab of MMVF and consolidating the granulated material. The binder may be any of the binders known for use as binders for coherent MMVF products. The MMVF substrate may comprise a wetting agent.

**[0016]** The MMVF substrate is hydrophilic, that is it attracts water. The MMVF substrate is hydrophilic due to the binder system used. In the binder system, the binder itself may be hydrophilic and/or a wetting agent used.

**[0017]** The hydrophilicity of a sample of MMVF substrate can be measured by determining the sinking time of a sample. A sample of MMVF substrate having dimensions of 100x100x65 mm is required for determining the sinking time. A container with a minimum size of 200x200x200 mm is filled with water. The sinking time is the time from when the sample first contacts the water surface to the time when the test specimen is completely submerged. The sample is placed in contact with the water in such a way that a cross-section of 100x100 mm first touches the water. The sample will then need to sink a distance of just over 65mm in order to be completely submerged. The faster the sample sinks, the more hydrophilic the sample is. The MMVF substrate is considered hydrophilic if the sinking time is less than 120 s. Preferably the sinking time is less than 60 s. In practice, the MMVF substrate may have a sinking time of a few seconds, such as less than 10 seconds.

**[0018]** When the binder is hydrophobic, in order to ensure that the substrate is hydrophilic, a wetting agent is additionally included in the MMVF substrate. A wetting agent will increase the amount of water that the MMVF substrate can absorb. The use of a wetting agent in combination with a hydrophobic binder results in a hydrophilic MMVF substrate. The wetting agent may be any of the wetting agents known for use in MMVF substrates that are used as growth substrates. For instance it may be a non-ionic wetting agent such as Triton X-100 or Rewopal. Some non-ionic wetting agents may be washed out of the MMVF substrate over time. It is therefore preferable to use an ionic wetting agent, especially an anionic wet-

ting agent, such as linear alkyl benzene sulphonate. These do not wash out of the MMVF substrate to the same extent.

**[0019]** EP1961291 discloses a method for producing water-absorbing fibre products by interconnecting fibres using a self-curing phenolic resin and under the action of a wetting agent, characterised in that a binder solution containing a self-curing phenolic resin and polyalcohol is used. This type of binder can be used in the present invention. Preferably, in use the wetting agent does not become washed out of the MMVF substrate and therefore does not contaminate the surrounding ground.

**[0020]** The binder of the MMVF substrate can be hydrophilic. A hydrophilic binder does not require the use of a wetting agent. A wetting agent can nevertheless be used to increase the hydrophilicity of a hydrophilic binder in a similar manner to its action in combination with a hydrophobic binder. This means that the MMVF substrate will absorb a higher volume of water than if the wetting agent is not present. Any hydrophilic binder can be used.

**[0021]** The binder may be a formaldehyde-free aqueous binder composition comprising: a binder component (A) obtainable by reacting at least one alkanolamine with at least one carboxylic anhydride and, optionally, treating the reaction product with a base; and a binder component (B) which comprises at least one carbohydrate, as disclosed in WO2004/007615. Binders of this type are hydrophilic.

**[0022]** WO97/07664 discloses a hydrophilic substrate that obtains its hydrophilic properties from the use of a furan resin as a binder. The use of a furan resin allows the abandonment of the use of a wetting agent. Binders of this type may be used in the present invention.

**[0023]** WO07129202 discloses a hydrophilic curable aqueous composition wherein said curable aqueous composition is formed in a process comprising combining the following components:

(a) a hydroxy-containing polymer,
(b) a multi-functional crosslinking agent which is at least one selected from the group consisting of a polyacid, salt(s) thereof and an anhydride, and
(c) a hydrophilic modifier;

wherein the ratio of (a):(b) is from 95:5 to about 35:65.

**[0024]** The hydrophilic modifier can be a sugar alcohol, monosaccharide, disaccharide or oligosaccharide. Examples given include glycerol, sorbitol, glucose, fructose, sucrose, maltose, lactose, glucose syrup and fructose syrup. Binders of this type can be used in the present invention.

**[0025]** Further, a binder composition comprising:

a) a sugar component, and
b) a reaction product of a polycarboxylic acid component and an alkanolamine component,

wherein the binder composition prior to curing contains at least 42% by weight of the sugar component based on the total weight (dry matter) of the binder components may be used in the present invention, preferably in combination with a wetting agent.

**[0026]** Binder levels are preferably in the range 0.5 to 5 wt%, preferably 2 to 4 wt%, based on the weight of the MMVF substrate.

**[0027]** Levels of wetting agent are preferably in the range 0 to 1 wt%, based on the weight of the MMVF substrate, in particular in the range 0.2 to 0.8 wt%, especially in the range 0.4 to 0.6 wt%.

**[0028]** The MMVF product may be made by any of the methods known to those skilled in the art for production of MMVF growth substrate products. In general, a mineral charge is provided, which is melted in a furnace to form a mineral melt. The melt is then formed into fibres by means of centrifugal fiberisation e.g. using a spinning cup or a cascade spinner, to form a cloud of fibres. These fibres are then collected and consolidated. Binder and optionally wetting agent are usually added at the fiberisation stage by spraying into the cloud of forming fibres. These methods are well known in the art.

**[0029]** The present invention provides a structure for draining surface water according to claim 1, comprising a coherent force distribution layer and a drain layer, wherein the drain layer is formed of an array of coherent man-made vitreous fiber (MMVF) drain elements, wherein each of the drain elements comprises man-made vitreous fibres bonded with a cured binder composition, wherein the drain layer is below the force distribution layer.

**[0030]** Each of the drain elements has opposed first and second ends and a passage within the drain element which extends from a first opening in the first end to a second opening in the second end. The advantage of a passage is that this gives a defined path for the water to flow through.

**[0031]** Preferably the openings of the passages of two drain elements are aligned to allow water to pass through the two drain elements. This means that two of the openings are lined up with each other so as to allow water to pass from the passage of one drain element into the passage of the other drain element and vice versa.

The passage in at least one drain element may be at an angle of 0.5 to 5° from horizontal, preferably 1- 4° from horizontal, preferably 1-3° from horizontal. Preferably the second opening is higher than the first opening. The advantage of a sloping passage is that water can flow towards the first opening of the passage. The water can then be disposed of. Preferably the water flows via the first opening to a water disposal point, preferably a tank mains drainage, or a water drain reservoir.

**[0032]** Alternatively, the passage within at least one drain element may be horizontal.

**[0033]** Preferably the passages within two drain elements are connected and form an inverted V shape with respect to the horizontal. This allows water to be directed

in two directions for disposal away from the mid point of the inverted V, rather than requiring all the water to flow in one direction. This particularly useful when the drained area is large, such as a football pitch. In order to provide a passage at an angle from the horizontal, the passage can be formed at an angle with respect to the top of the MMVF substrate, or the MMVF substrate can be installed so that its top surface at an angle with the horizontal. The passage may be at an angle with respect to the top surface of the MMVF substrate. It is highly desirable that the top of the MMVF substrate is substantially level so that the force distribution layer can be arranged directly on top of the MMVF substrate. This gives a level surface on which the force distribution layer can be positioned.

**[0034]** Preferably, the passage is enclosed within the MMVF of the drain element, except at the first and second openings. This prevents any debris from entering the passage along the length of the passage. Alternatively, the passage may be exposed at the top surface of the drain element such that the passage is enclosed by the layer above the drain element, for example, the force distribution layer.

**[0035]** The MMVF substrate that is used as drain element in the present invention preferably has a density in the range of 60 to 280 kg/m$^3$, preferably in the range of 70 to 150 kg/m$^3$, more preferably 100 to 130 kg/m$^3$, such as around 110 kg/m$^3$. The density of the MMVF substrate is the density of the MMVF substrate as such, that is the density of the MMVF substrate excluding a passage, if present. The optional passage is not taken into account when calculating the density of the MMVF substrate.

**[0036]** The advantage of density in this range is that the MMVF substrate has a relatively high compression strength. This is important because the MMVF substrate will be installed in a position where people need to travel over the ground in which the MMVF substrate is positioned.

**[0037]** In an example, which does not form part of the present invention, some of the drains may not have passages. The advantage of having some drains without passages is that there are less passages to connect to a water disposal point.

**[0038]** The advantage of more of the drains have a passage is that water can flow more easily through the passages to a water disposal point than through the drains without passages.

**[0039]** Preferably at least 20 % of the drains comprise a passage, more preferably at least 40 %, more preferably at least 50 %, more preferably at least 80 %, most preferably all of the drains comprise a passage.

**[0040]** Preferably the drain layer covers the whole area which is to be drained with the drain elements arranged in parallel rows. Preferably the drain elements are arranged in at least one row, preferably a plurality of parallel rows. In the case of a pitch such as a football pitch, the drain layer will cover the whole area under the pitch.

**[0041]** The cross-sectional width and height of each drain element are preferably each independently in the range 10 to 80 cm, more preferably 15 to 60 cm. The advantage of using a drain element with these widths and heights is that it is large enough to be able to store water within the pores of the MMVF substrate and thus buffer an amount of water. The widths and heights are small enough for it to be straightforward to install the drain underground. The drain elements may optionally have a greater height and/or width, but this will increase the time and effort required to install the drain.

**[0042]** The length of each drain element may be any length, but will normally be in the range of 50 cm to 200 cm, such as around 100 cm. In use the drain will normally be combined with other drain elements as required to cover the area to be drained.

**[0043]** It is envisaged that several drain elements could be in fluid communication with each other by lining up their ends and passages, where present, in order to create a longer drain.

**[0044]** The volume of each of the drain elements is preferably in the range 5000 to 700,000 cm$^3$, more preferably 20,000 to 200,000 cm$^3$. The precise volume is chosen according to the volume of water which is expected to be managed.

**[0045]** Preferably the drain elements have a rectangular or square cross-section which makes it easy to manufacture and reduces production wastage of the MMVF substrate. Drain elements with rectangular or square cross-section can be installed in close connection with each other as they can abut each other. Alternatively the cross-section may be circular, triangular or any convenient shape.

**[0046]** Preferably the cross-sectional area of the drain element is substantially uniform along the length. Substantially uniform means that the cross-sectional area at all points along the length remains within 10 % of the average cross-sectional area, preferably within 5 %, most preferably within 1 %.

**[0047]** Preferably the cross-sectional area of the first and second openings are in the range 2 to 200 cm$^2$, preferably 5 to 100 cm$^2$.

**[0048]** Preferably the cross-sectional area of the first opening is in the range 0.5 % to 15 % of the cross-sectional area of the first end MMVF substrate, more preferably 1 % to 10 %.

**[0049]** Preferably the cross-sectional area of the second opening is in the range 0.5 % to 15 % of the cross-sectional area of the second end MMVF substrate, more preferably 1 % to 10 %.

**[0050]** The openings are such a small percentage of the cross-sectional area of the ends of the drain since the vast majority of the MMVF substrate is used to buffer the amount of water that is to be conveyed. The larger the proportion of the MMVF substrate, the greater the volume of water that can be buffered by a drain of a given cross-sectional area.

**[0051]** The cross-sectional area of the passage is preferably substantially uniform along the length of the MMVF substrate. Substantially uniform means that the cross-

sectional area is within 10 % of the average cross-sectional area, preferably within 5 %, most preferably within 1 %. If necessary however, the cross-sectional area can be varied according to the requirements of the passage to be smaller or larger.

**[0052]** The passage is preferably configured so that each passage takes the most direct route through the MMVF substrate to allow water to take the most direct route along the passage to the second opening. This is for ease of manufacture.

**[0053]** The passage may have a triangular cross-sectional area. When installed, the base of the triangle is preferably parallel with the base of the drain. Alternatively the passage can have a semi-circular cross-sectional area. Again, the base of the drain is preferably parallel with the base of the semicircle. Alternatively, the passage can have a circular or a rectangular cross-sectional area.

**[0054]** The passage is preferably positioned substantially centrally in the width of the cross-section of the drain element. The reason for this is so that the flow of water which is then along a line in the centre of the drain element. This has the advantage that the strength of the drain is maintained at the sides of the drain. If however the passage were arranged close to one side of the drain element, this may reduce the strength of the structure.

**[0055]** Preferably the passage is offset towards a first direction. The advantage of this is that the drain may be installed with the passage at the bottom of the drain element, and it is easier to drain the water from the drain element since there is a smaller volume of MMVF substrate below the passage. This means that when the drain element takes on water, there is a smaller volume to saturate with water below the passage before the excess water goes into the passage and can be removed. If the drain element were to be installed with the passage at the top there would be a larger volume of MMVF substrate which would need to be saturated with water before the excess water goes into the passage and can be removed.

**[0056]** The drain element may comprise a first part in contact with a second part, wherein the passage is disposed between the first part and the second part. This can be achieved by providing a first part which is preformed so that it has a groove along the length of the MMVF substrate, and when the first part and second parts are placed together, the passage is formed by the groove and the second part. Alternatively the second part may have the groove. Alternatively, both the first and second part may have a groove and the grooves may be lined up to form the passage when the first and second parts are joined together. The groove or grooves may be of any shape, as required to form the passage. The groove or grooves may therefore have a cross-section which is semi-circular, triangular, rectangular or the like.

**[0057]** The first and second parts of the MMVF substrate may simply be placed in contact, or they may be connected, e.g. using an adhesive.

**[0058]** Preferably the passage is formed of a pipe, preferably a perforated plastic pipe, such as a PVC pipe. The pipe gives strength to the drain and prevents the passage from becoming closed. The pipe is perforated in order to allow the water to drain into the passage.

**[0059]** Preferably the water holding capacity of the MMVF substrate is at least 80 % of the volume of the substrate, preferably 80-99 %, most preferably 85-95 %. The greater the water holding capacity, the more water can be stored for a given substrate volume. The water holding capacity of the MMVF substrate is high due to the open pore structure and the MMVF substrate preferably being hydrophilic.

**[0060]** Preferably the amount of water that is retained by the MMVF substrate when it emits water is less than 20 %vol, preferably less than 10 %vol, most preferably less than 5 %vol based on the volume of the substrate. The water retained may be 2 to 20 %vol, such as 5 to 10 %vol. The lower the amount of water retained by the MMVF substrate, the greater the capacity of the MMVF substrate to take on more water. Water may leave the MMVF substrate by water being conveyed by the passage to a disposal means and/or by dissipating into the ground when the surrounding ground is dry and the capillary balance is such that the water dissipates into the ground.

**[0061]** Preferably the buffering capacity of the MMVF substrate, that is the difference between the maximum amount of water that can be held, and the amount of water that is retained when the MMVF substrate gives off water is at least 60 %vol, preferably at least 70 %vol, preferably at least 80 %vol. The buffering capacity may be 60 to 90 %vol, such as 60 to 85 %vol based on the volume of the substrate. The advantage of such a high buffering capacity is that the MMVF substrate can buffer more water for a given substrate volume, that is the MMVF substrate can store a high volume of water when required, and release a high volume of water into the surrounding ground once the has ground dried out. The buffering capacity is so high because MMVF substrate requires a low suction pressure to remove water from the MMVF substrate. This is demonstrated in the Example.

**[0062]** The water holding capacity, the amount of water retained and the buffering capacity of the MMVF substrate can each be measured in accordance with EN 13041 - 1999.

**[0063]** The coherent force distribution layer is present in order to ensure that a drain elements are not destroyed and/or does not move out of position when pressure is applied to it, for example by a person running or jumping on it. The force distribution layer ensures that force impacting from the ground surface is not concentrated on a single point of a drain element, but is instead distributed over a larger area. The force distribution layer may be made of a plurality of plates in order to cover the whole area to be drained. Each plate may have a width and length in the range of 0.5 to 5 m, preferably 1 to 3 m, more preferably 1 to 2 m. The force distribution layer is a plastic layer, a rubber layer or an MMVF layer. The force distribution layer must allow water to pass through

it to the drain elements. Where the force distribution layer is made of plastic or rubber, the layer may be perforated to allow water to pass through it to the drain elements. The thickness of the force distribution layer is preferably up to 10cm, preferably 1-5 cm depend on material it is made from. The force distribution layer needs to be thick enough to distribute force across more than one drain element, and shallow enough to allow easy installation and water permeation. Preferably the force distribution layer covers the whole of the drain layer present.

**[0064]** When the force distribution layer is a coherent MMVF layer, it preferably has a compressive strength of at least 20 kPa, such as 30 kPa to 100 kPa, preferably 30 to 60 kPa, and the compressive strength may be up to 20 MPa. The compressive strength is measured according to European Standard EN 826:1996. Force distribution layers with such a compressive strength are particularly suitable for use in the present invention as they ensure that force impacting from the ground surface is not concentrated on a single point of a drain element, but is instead distributed over a larger area.

**[0065]** When the force distribution layer is a coherent MMVF layer, it preferably has a density of at least 100 $kg/m^3$, such as 100 to 280 $kg/m^3$, preferably 150 to 200 $kg/m^3$, and the density may be up to 600 $kg/m^3$. Force distribution layers with such a density are particularly suitable for use in the present invention as they ensure that force impacting from the ground surface is not concentrated on a single point of a drain element, but is instead distributed over a larger area.

**[0066]** When the force distribution layer is a coherent MMVF layer, it is preferably hydrophilic, that is it attracts water. The MMVF layer is in the form of a coherent mass. That is, the MMVF layer is generally a coherent matrix of MMVF fibres, which has been produced as such, but can also be formed by granulating a slab of MMVF and consolidating the granulated material. The binder may be any of the binders known for use as binders for coherent MMVF products. The MMVF layer may comprise a wetting agent. The binder and optional wetting agent of the MMVF layer may be as described for the MMVF substrate.

**[0067]** The structure can further comprise an upper layer above the force distribution layer. The upper layer is preferably grass, earth, artificial grass, sand, gravel, clay or combinations thereof.

**[0068]** The structure can further comprise a heating layer between the force distribution layer and the drain layer. A heating layer is particularly useful to defrost pitches, such as football pitches in cold weather. Where the structure comprises an upper layer, a heating layer, a force distribution layer and a drain layer, the heating layer can be positioned between the upper layer and the force distribution layer.

**[0069]** The present invention relates to a structure for draining surface water according to claim 1, comprising a coherent force distribution layer and a second layer, wherein the second layer is formed of an array of coherent man-made vitreous fiber (MMVF) elements, wherein each of the elements comprises man-made vitreous fibres bonded with a cured binder composition, wherein the second layer is below the force distribution layer. The second layer is a drain layer and the coherent MMVF elements are coherent MMVF drain elements.

**[0070]** Each of the drain elements has opposed first and second ends and a passage which extends from a first opening in the first end to a second opening in the second end, whereby water in fluid communication with the first drain is: (i) absorbed by the MMVF substrate, and/or (ii) conveyed along the passage.

**[0071]** An advantage of using the structure according to the invention is that the drain elements can absorb water and store it within its open pore structure and the drain elements can convey water along the passage towards the first opening. This means that the drain elements can store water when required, and also convey water to a water disposal point when required. An advantage of storing the water is that when the surrounding ground is dry enough, the water stored in the MMVF substrate can dissipate from the substrate into the ground. This means that it is not always necessary to remove the water and arrange to dispose of it. The drain elements can store the water and then gradually dissipate it to the ground when the capillary balance between the MMVF substrate and the ground allows the water to dissipate into the ground.

**[0072]** The water can be conveyed by gravity along the passage, for example, by installing the passage with a slope such that the second end of the MMVF substrate is higher than the first end of the MMVF substrate as discussed above. An advantage of installing the drain with a slope is that it is not necessary to pump the water from the drain element.

**[0073]** Alternatively, a pump can be provided which is in fluid communication with the first opening of the passage, wherein the pump conveys water towards the first opening of the passage. The pump may be in fluid communication with the first opening by means of a conduit, such as a pipe. The water can be pumped along the passage to a water disposal point such as a tank, mains drainage or a water drain reservoir. An advantage of using a pump is that the drain element can be installed in such a way that the passage is not at an angle with the horizontal and therefore on installation it is not necessary to ensure that the passage has the required angle.

**[0074]** It is possible to have both install the MMVF substrate passage on a slope and use a pump system.

In use, the passage is preferably offset and positioned in the lower half of the MMVF substrate. It is advantageous for the passage to be at the bottom of the MMVF substrate as this means that there is a smaller volume of MMVF substrate to saturate with water before the water goes into the passage.

**[0075]** It is not necessary to wrap the drain of the present invention in any geo-textile material on installation because the MMVF substrate acts like a filter itself

in order to prevent any contaminate such as earth entering the drain element and blocking the passage.

**[0076]** There is provided a method of installing a structure for draining surface water according to claim 11, comprising positioning a drain layer in the ground, wherein the drain layer is formed of an array of coherent man-made vitreous fiber (MMVF) drain elements, wherein each of the drain elements comprises man-made vitreous fibres bonded with a cured binder composition, and positioning a coherent force distribution layer above the drain layer.

**[0077]** Each of the drain elements has opposed first and second ends and a passage which extends from a first opening in the first end to a second opening in the second end, wherein the first opening of the drain is arranged in fluid communication with a water disposal point.

**[0078]** Preferably the drainage system is installed by digging out an area which is to be drained, positioning the drain elements in the area in fluid communication with each other area so that a layer of drain elements covers the entire area to be drained, positioning a coherent force distribution layer on top of the drain layer and optionally positioning an upper layer on top of the force distribution layer. In this way, a level surface is created through which surface water can drain.

**[0079]** In this method, the MMVF substrates may be installed so that the passages are on a slope, and/or connected to a pump.

**[0080]** There is provided a method of draining surface water according to claim 12, the method comprising providing a coherent force distribution layer and a drain layer, wherein the drain layer is formed of an array of coherent man-made vitreous fiber (MMVF) drain elements, wherein each of the drain elements comprises man-made vitreous fibres bonded with a cured binder composition, wherein the drain layer is below the force distribution layer, whereby water in fluid communication with the drain elements is: (i) absorbed by the MMVF substrate, and/or (ii) conveyed along the drain elements.

**[0081]** Each of the drain elements has opposed first and second ends and a passage which extends from a first opening in the first end to a second opening in the second end, whereby water in fluid communication with the first drain is: (i) absorbed by the MMVF substrate, and/or (ii) conveyed along the passage.

## Brief description of figures

**[0082]**

Figure 1 shows a cross-sectional view of a structure with a drain element

Figure 2 shows a cross-sectional view of a structure with a drain element with a passage

Figure 3 shows a cross-sectional view of a structure with a two drain elements, each with a passage

Figure 4 shows a cross-sectional view of a structure with a drain element and a heating layer

Figure 5 shows a cross-sectional view of a structure with a drain element and an upper layer

Figure 6 shows a section view of a structure with an array of drain elements

Figure 7 shows the water holding capacity of an MMVF substrate according to the invention as discussed in the Example

## Detailed description of figures

**[0083]** Figure 1 shows a force distribution layer 1 above a drain element 2.

**[0084]** Figure 2 shows a force distribution layer 1a above a drain element 2a. The drain element 2a has a passage 3a running from the first end of the drain element to the second end of the drain element. The passage 3a is sloped to allow water to flow along the passage towards the lowest point. The water then flows from the passage to a water disposal point 4a.

**[0085]** Figure 3 shows a force distribution layer 1b above a first drain element 2b and a second drain element 5b. The first drain element 2b and second drain element 5b each have a passage 3b and 6b respectively. The passages 3b and 6b are each at an angle and the passages are aligned at the highest point. In this way the water can flow through either passage, depending which drain element the water enters. The water flows to two water disposal points, 4b and 7b respectively. The water disposal points 4b and 7b could be the same water disposal point.

**[0086]** Figure 4 shows a force distribution layer 1c above a heating layer 8c. The drain elements 2c, 9c and 10c are each directly below the heating layer. Drain element 9c is disposed between drain elements 2c and 10c. A horizontal passage 3c runs through each of the drain elements 2c, 9c and 10c. This shows how multiple drain elements can be in fluid communication which each other to form the structure.

**[0087]** Figure 5 shows an upper layer 11d above a force distribution layer 1d. A drain element 2d is below the force distribution layer.

**[0088]** Figure 6 shows a force distribution layer 1e, above a drain layer. The drain layer comprises an array of drain elements 2e and spacing elements 12e. Each drain element has a passage 3e extending from one end of the drain element to the other end of the drain element. Some of the drain elements 2e are aligned to the next drain element 2e by aligning the passages 3e to create a row of drain elements 2e. The spacing elements 12e are aligned in rows between the rows of drain elements 2e. The force distribution layer 1e is shown partially covering the drain layer, but in practice will completely cover the drain layer. The spacing elements may be drain elements without a passage. Alternatively, the spacing elements may comprise an MMVF substrate which is hydrophobic. The drain layer as a whole is still able to drain surface water, whether the spacing elements are hy-

drophilic or hydrophobic as the drain elements 2e are sufficient to drain the surface water.

**[0089]** The invention will now be described in the following example which does not limit the scope of the invention.

Example

**[0090]** The water holding capacity of a MMVF substrate and silt loam were tested in accordance with EN 13041 - 1999. The MMVF substrate was a stone wool fibre product with a phenol-urea formaldehyde (PUF) binder and a non-ionic surfactant wetting agent. The results are shown in Figure 7.

**[0091]** The MMVF substrate has a maximum water content of 90 %vol based on the substrate volume. When the MMVF substrate gives off water, it retains about 2-5 %vol of water. This means that the MMVF substrate has a buffering capacity of 85-87 %vol. This shows that the MMVF substrate has a high maximum water content, as well as a lower water retention level.

**[0092]** The maximum water content of the silt loam is lower than the MMVF substrate. The capillarity of the silt loam is much higher than that of the MMVF substrate, which means a suction pressure of several meters is required in order to withdraw water from the silt loam. This means that the soil will easily drain water from the MMVF substrate as soon as the soil is not saturated.

**Claims**

1. A structure for draining surface water, comprising a coherent force distribution layer (1) and a drain layer, wherein the drain layer is below the force distribution layer,
   **characterised in that** the drain layer is formed of an array of coherent man-made vitreous fiber (MMVF) drain elements (2), wherein each of the drain elements comprises man-made vitreous fibres bonded with a cured binder composition ;wherein each of the drain elements has opposed first and second ends and a passage (3a) which extends from a first opening in the first end to a second opening in the second end; wherein the MMVF drain elements comprise a hydrophilic binder and/or a wetting agent; and wherein the force distribution layer comprises a continuous plastic layer, a continuous rubber layer, or a coherent MMVF layer.

2. A structure according to claim 1, wherein the openings of the passages of two drain elements are aligned.

3. A structure according to any preceding claim, wherein the drain elements are arranged in at least one row, preferably a plurality of parallel rows.

4. A structure according to any of claims 1 to 3, wherein the passage in at least one of the drain elements is at an angle of 0.5 to 5° from horizontal, preferably 1-4° from horizontal, preferably 1-3° from horizontal and the second opening is higher than the first opening.

5. A structure according to any of claims 1 to 4, wherein the passage is in the bottom half of the MMVF drain element.

6. A structure according to any preceding claim, wherein the MMVF drain elements comprises a wetting agent.

7. A structure according to any preceding claim for draining recreation grounds, preferably sports grounds.

8. A structure according to any preceding claim, further comprising an upper layer above the force distribution layer, wherein the upper layer is preferably grass, earth, artificial grass, sand, gravel, clay, or a combination thereof.

9. A structure according to any preceding claim wherein the system further comprises a heating layer between the force distribution layer and the drain layer.

10. A structure according to any preceding claim, wherein the array of drain elements is in fluid communication with a water disposal point, preferably a tank, mains drainage or water drain reservoir.

11. A method of installing a structure for draining surface water, the method comprising:

    positioning a drain layer in the ground, **characterised in that** the drain layer is formed of an array of coherent man-made vitreous fiber (MMVF) drain elements (2), wherein each of the drain elements comprises man-made vitreous fibres bonded with a cured binder composition and;
    positioning a coherent force distribution layer (1) above the drain layer; wherein each of the drain elements has opposed first and second ends and a passage (3a) which ,extends from a first opening in the first end to a second opening in the second end, wherein the first opening of the drain is arranged in fluid communication with a water disposal point; wherein the MMVF drain element comprise a hydrophilic binder and/or a wetting agent and wherein the force distribution layer comprises a continuous plastic layer, a continuous rubber layer, or a coherent MMVF laye..

**12.** A method of draining surface water, the method comprising providing a coherent force distribution layer (1) and a drain layer, **characterised in that** the drain layer is formed of an array of coherent man-made vitreous fiber (MMVF) drain elements (2), wherein each of the drain elements comprises man-made vitreous fibres bonded with a cured binder composition, wherein the drain layer is below the force distribution layer, whereby water in fluid communication with the drain elements is: (i) absorbed by the MMVF substrate, and/or (ii) conveyed along the drain elements; wherein each of the drain elements has opposed first and second ends and a passage (3a) which extends from a first opening in the first end to a second opening in the second end, whereby water in fluid communication with the first drain is: (i) absorbed by the MMVF substrate, and/or (ii) conveyed along the passage; wherein the MMVF drain element comprise a hydrophilic binder and/or a wetting agent; and wherein the force distribution layer comprises a continuous plastic layer, a continuous rubber layer, or a coherent MMVF layer.

**13.** A method according to claim 11 or 12, further comprising the features of any of claims 2 to 10.

**Patentansprüche**

**1.** Gebilde zur Ableitung von Oberflächenwasser, das eine zusammenhängende Kraftverteilungsschicht (1) und eine Ableitschicht aufweist, wobei die Ableitschicht unterhalb der Kraftverteilungsschicht ist, **dadurch gekennzeichnet, dass** die Ableitschicht von einer Anordnung zusammenhängender Ableitelemente (2) mit synthetischen Glasfasern (MMVF) gebildet wird, wobei jedes der Ableitelemente synthetische Glasfasern aufweist, die mit einer gehärteten Bindemittelzusammensetzung gebunden sind, wobei jedes der Ableitelemente einander entgegengesetzte Enden und einen Durchgang (3a) hat, der sich von einer ersten Öffnung im ersten Ende zu einer zweiten Öffnung im zweiten Ende erstreckt; wobei die MMVF-Ableitelemente ein hydrophiles Bindemittel und/oder ein Netzmittel aufweisen; und wobei die Kraftverteilungsschicht eine kontinuierliche Plastikschicht, eine kontinuierliche Kautschukschicht oder eine zusammenhängende MMVF-Schicht aufweist.

**2.** Gebilde nach Anspruch 1, wobei die Öffnungen der Durchgänge der zwei Ableitelemente aufeinander ausgerichtet sind.

**3.** Gebilde nach einem der vorhergehenden Ansprüche, wobei die Ableitelemente in wenigstens einer Reihe, vorzugsweise mehreren parallelen Reihen, angeordnet sind.

**4.** Gebilde nach einem der Ansprüche 1 bis 3, wobei der Durchgang in wenigstens einem der Ableitelemente in einem Winkel von 0,5 bis 5° zur Horizontalen, vorzugsweise 1 bis 4° zur Horizontalen, vorzugsweise 1 bis 3° zur Horizontalen ist und die zweite Öffnung höher als die erste Öffnung ist.

**5.** Gebilde nach einem der Ansprüche 1 bis 4, wobei der Durchgang in der unteren Hälfte des MMVF-Ableitelements ist.

**6.** Gebilde nach einem der vorhergehenden Ansprüche, wobei die MMVF-Ableitelemente ein Netzmittel aufweisen.

**7.** Gebilde nach einem der vorhergehenden Ansprüche zum Entwässern von Freizeitanlagen, vorzugsweise Sportanlagen.

**8.** Gebilde nach einem der vorhergehenden Ansprüche, die ferner eine obere Schicht über der Kraftverteilungsschicht aufweist, wobei die obere Schicht vorzugsweise Gras, Erde, Kunstrasen, Sand, Kies, Ton oder eine Kombination davon ist.

**9.** Gebilde nach einem der vorhergehenden Ansprüche, wobei das System ferner eine Heizschicht zwischen der Kraftverteilungsschicht und der Ableitschicht aufweist.

**10.** Gebilde nach einem der vorhergehenden Ansprüche, wobei die Anordnung von Ableitelementen in Fluidverbindung mit einem Wasserentsorgungspunkt ist, vorzugsweise einem Tank, Abflusskanal oder Abwasserspeicher.

**11.** Verfahren zum Verlegen einer Gebilde zur Ableitung von Oberflächenwasser, wobei das Verfahren Folgendes aufweist:

Positionieren einer Ableitschicht im Boden, **dadurch gekennzeichnet, dass** die Ableitschicht von einer Anordnung zusammenhängender Ableitelemente (2) mit synthetischen Glasfasern (MMVF) gebildet wird, wobei jedes der Ableitelemente synthetische Glasfasern aufweist, die mit einer gehärteten Bindemittelzusammensetzung gebunden sind; und

Positionieren einer zusammenhängenden Kraftverteilungsschicht (1) oberhalb der Ableitschicht; wobei jedes der Ableitelemente ein erstes und ein zweites Ende, die einander entgegengesetzt sind, und einen Durchgang (3a) hat, der sich von einer ersten Öffnung im ersten Ende zu einer zweiten Öffnung im zweiten Ende erstreckt, wobei die erste Öffnung der Ableitung in Fluidverbindung mit einem Wasserentsorgungspunkt ist; wobei die MMVF-Ableitelemen-

te ein hydrophiles Bindemittel und/oder ein Netzmittel aufweisen und wobei die Kraftverteilungsschicht eine kontinuierliche Plastikschicht, eine kontinuierliche Kautschukschicht oder eine zusammenhängende MMVF-Schicht aufweist.

**12.** Verfahren zur Ableitung von Oberflächenwasser, wobei das Verfahren das Bereitstellen einer zusammenhängenden Kraftverteilungsschicht (1) und einer Ableitschicht aufweist, **dadurch gekennzeichnet, dass** die Ableitschicht von einer Anordnung zusammenhängender Ableitelemente (2) mit synthetischen Glasfasern (MMVF) gebildet wird, wobei jedes der Ableitelemente synthetische Glasfasern aufweist, die mit einer gehärteten Bindemittelzusammensetzung gebunden sind, wobei die Ableitschicht unterhalb der Kraftverteilungsschicht ist, so dass in Fluidverbindung mit den Ableitelementen stehendes Wasser: (i) durch das MMVF-Substrat absorbiert wird und/oder (ii) in den Ableitelementen entlangbefördert wird; wobei jedes der Ableitelemente ein erstes und ein zweites Ende, die einander entgegengesetzt sind, und einen Durchgang (3a) hat, der sich von einer ersten Öffnung im ersten Ende zu einer zweiten Öffnung im zweiten Ende erstreckt; so dass in Fluidverbindung mit der ersten Ableitung stehendes Wasser: (i) durch das MMVF-Substrat absorbiert wird und/oder (ii) im Durchgang entlangbefördert wird; wobei die MMVF-Ableitelemente ein hydrophiles Bindemittel und/oder ein Netzmittel aufweisen; und wobei die Kraftverteilungsschicht eine kontinuierliche Plastikschicht, eine kontinuierliche Kautschukschicht oder eine zusammenhängende MMVF-Schicht aufweist.

**13.** Verfahren nach Anspruch 11 oder 12, das ferner die Merkmale nach einem der Ansprüche 2 bis 10 aufweist.

**Revendications**

**1.** Une structure de drainage d'eau de surface composée d'une couche de distribution cohérente de force (1) et d'une couche de drainage, et cette couche de drainage se trouve sous la couche de distribution de force et cette structure se **caractérise par le fait que** la couche de drainage se compose d'une série d'éléments de drainage (2) en fibres vitreuses artificielles (FVA) cohérentes et chacun de ces éléments de drainage comporte des fibres vitreuses artificielles avec une composition à liant polymérisé et chacun de ces éléments de drainage a une première extrémité et une deuxième extrémité disposées en alternance et un passage (3a) qui part d'une première ouverture de la première extrémité et aboutit à une deuxième ouverture de la deuxième extrémités et les éléments de drainage en FVA se composent d'un liant hydrophile et (ou) d'un agent mouillant et la couche de distribution de force se compose d'une couche plastique continue, d'une couche continue en caoutchouc ou d'une couche en FVA cohérentes.

**2.** La structure que décrit la revendication 1, si ce n'est que les ouvertures des passages des deux éléments de drainage sont alignées.

**3.** La structure que décrit l'une ou l'autre des revendications précédentes, si ce n'est que les éléments de drainage sont disposés sur au moins une rangée, de préférence, sur une pluralité de rangées parallèles.

**4.** La structure que décrit l'une ou l'autre des revendications 1 à 3, si ce n'est que le passage d'au moins l'un des éléments de drainage se situe à un angle compris entre 0,5 et 5° par rapport à l'horizontale, de préférence à un angle compris entre 1 et 4° par rapport à rapport à l'horizontale, de préférence à un angle compris entre 1 et 3° par rapport à l'horizontale, alors que la deuxième ouverture se situe audessus de la première ouverture.

**5.** La structure que décrit l'une ou l'autre des revendications 1 à 4, si ce n'est que le passage se situe dans la moitié inférieure de l'élément de drainage à FVA.

**6.** La structure que décrit l'une ou l'autre des revendications précédentes, si ce n'est que les éléments de drainage à FVA contiennent un agent mouillant.

**7.** La structure que décrit l'une ou l'autre des revendications précédentes, si ce n'est qu'elle est conçue pour assurer le drainage de terrains de loisir, de préférence des terrains de sports.

**8.** La structure que décrit l'une ou l'autre des revendications précédentes, si ce n'est que ce système comporte en outre une couche supérieure au-dessus de la couche de distribution de force, et que cette couche supérieure est, de préférence, de la pelouse, de la terre, du gazon artificiel, du sable, des graviers, de l'argile ou une combinaison de ces possibilités.

**9.** La structure que décrit l'une ou l'autre des revendications précédentes, si ce n'est que ce système comporte en outre une couche de chauffage qui vient s'intercaler entre la couche de distribution de force et la couche de drainage.

**10.** La structure que décrit l'une ou l'autre des revendications précédentes, si ce n'est que la série d'éléments de drainage est en communication fluide avec un point d'évacuation de l'eau, de préférence une cuve, le tout-à l'égout ou un réservoir de drainage

de l'eau.

**11.** Un procédé d'installation d'une structure de drainage de l'eau de surface et ce procédé se compose des éléments suivants :

la mise en position d'une couche de drainage dans le sol qui se **caractérise par le fait que** cette couche de drainage est formée d'une série d'éléments de drainage (2) en fibres vitreuses artificielles (FVA) cohérentes et que chacun de ces éléments de drainage comporte des fibres vitreuses artificielles avec une composition à liant polymérisé et
la mise en position d'une couche de distribution de force cohérente (1) implantée au-dessus de la couche de drainage, si ce n'est que chacun des éléments de drainage a une première extrémité et une deuxième extrémité disposées en alternance et un passage (3a) qui part d'une première ouverture de la première extrémité et aboutit à une deuxième ouverture de la deuxième extrémités et si ce n'est que la première extrémité du drainage est en communication fluide avec un point d'évacuation de l'eau, si ce n'est que l'élément de drainage à FVA se compose d'un liant hydrophile et (ou) d'un agent mouillant et que la couche de distribution de force se compose d'une couche plastique continue, d'une couche continue en caoutchouc ou d'une couche en FVA cohérentes.

**12.** Un procédé de drainage d'eau de surface et ce procédé consiste à fournir une couche cohérente de distribution de force (1) et une couche de drainage et se **caractérise par le fait que** cette couche de drainage se compose d'une série d'éléments de drainage (2) en fibres vitreuses artificielles (FVA) cohérentes et chacun de ces éléments de drainage comporte des fibres vitreuses artificielles avec une composition à liant polymérisé et cette couche de drainage vient se placer sous la couche de distribution de force, et l'eau qui est en communication fluide avec les éléments de drainage est : i) absorbée par la surface de base en FVA et (ou) ii) acheminée le long des éléments de drainage ; et chacun de ces éléments de drainage a une première extrémité et une deuxième extrémité disposées en alternance et un passage (3a) qui part d'une première ouverture de la première extrémité et aboutit à une deuxième ouverture de la deuxième extrémité et l'eau qui est en communication fluide avec le premier drainage est : i) absorbée par la surface de base en FVA et (ou) ii) acheminée le long du passage ; et l'élément de drainage à FVA se compose d'un liant hydrophile et (ou) d'un agent mouillant et la couche de distribution de force se compose d'une couche plastique continue, d'une couche continue en caoutchouc ou d'une couche en FVA cohérentes.

**13.** Le procédé que décrit la revendication 11 ou 12, si ce n'est qu'il contient en outre les caractéristiques décrites dans l'une ou l'autre des revendications 2 à 10.




Figure 1

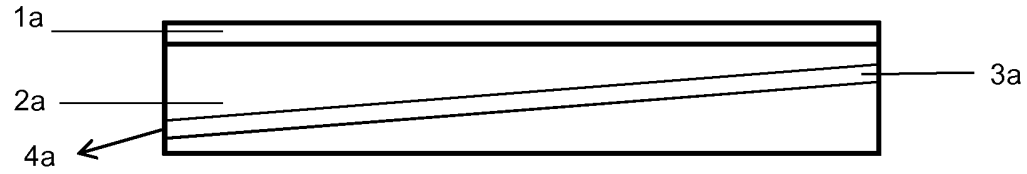



Figure 2

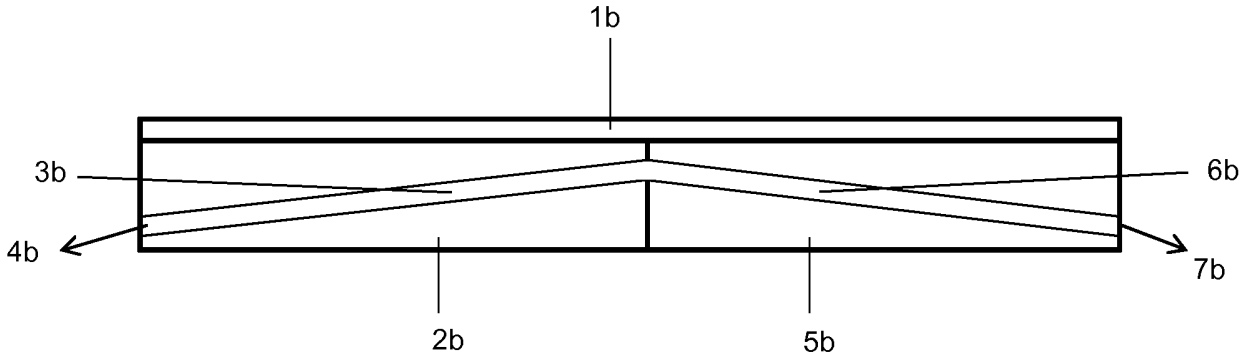



Figure 3

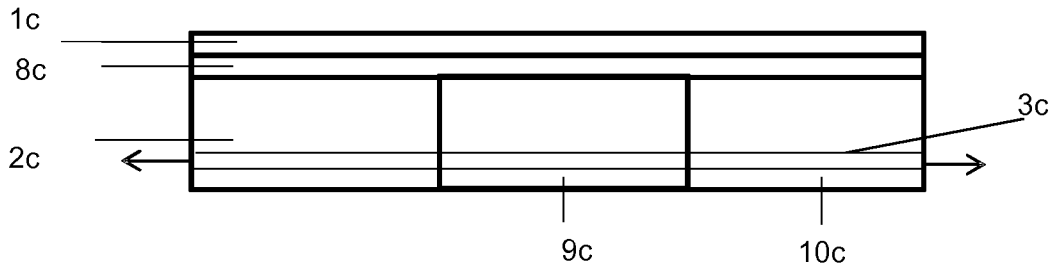



Figure 4

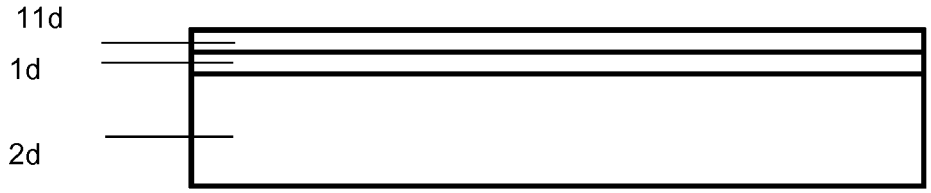



Figure 5

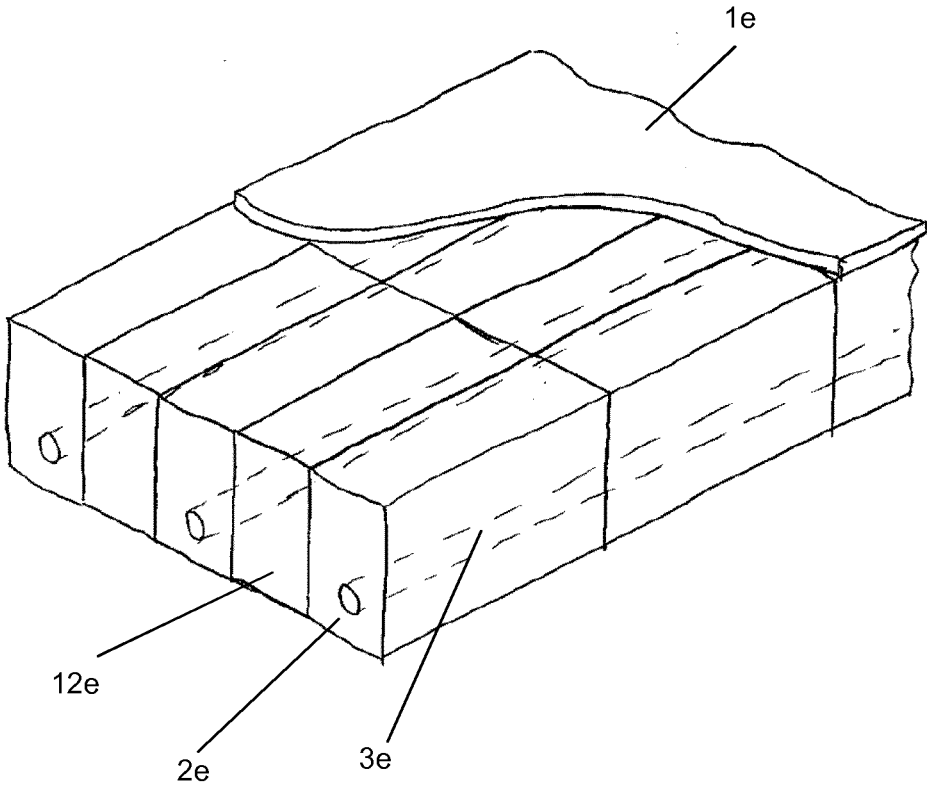



Figure 6

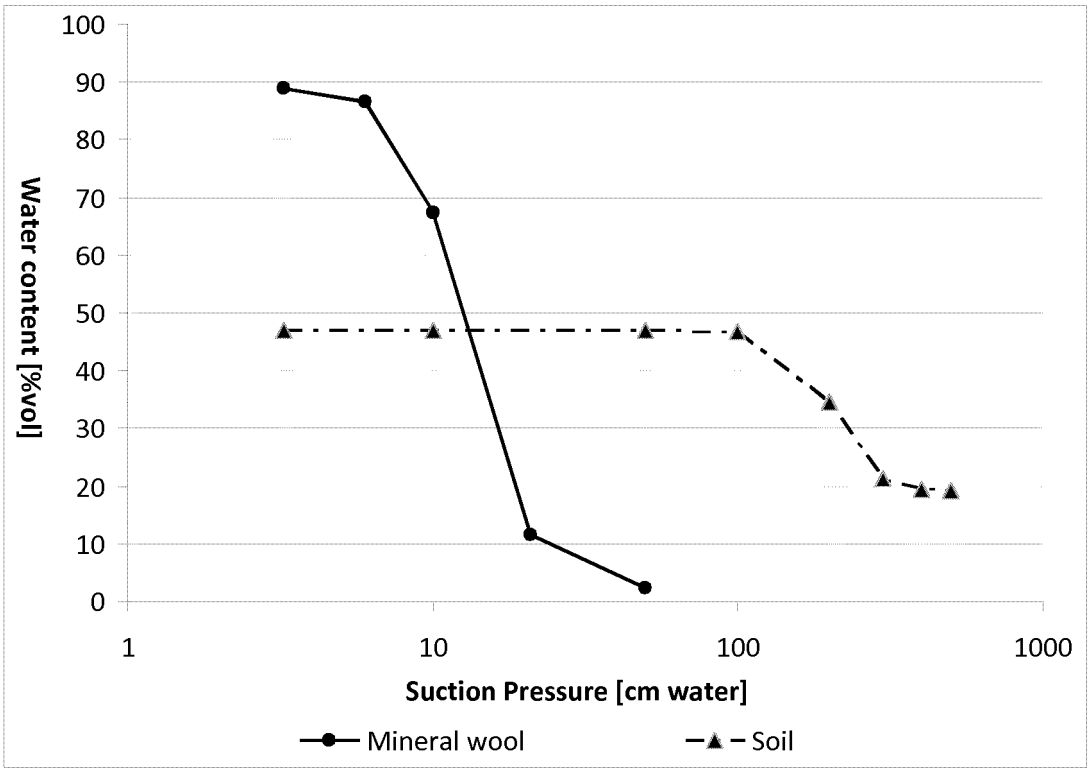

100
90
80
70
60
50
40
30
20
10
0
Water content [%vol]
1
10
100
1000
Suction Pressure [cm water]
Mineral wool
Soil

Figure 7

## REFERENCES CITED IN THE DESCRIPTION

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