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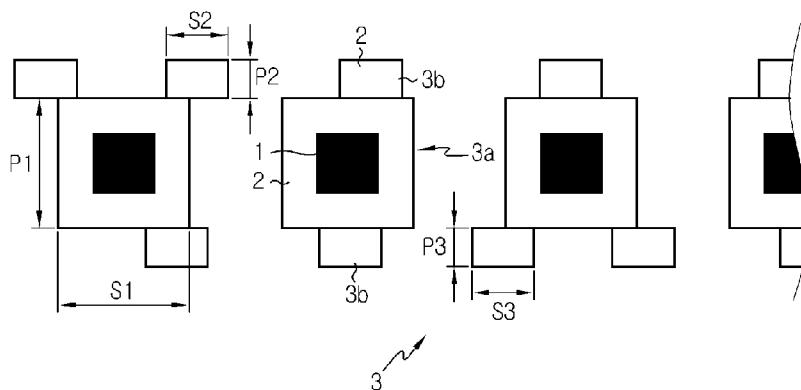
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[Fig. 3]



(57) Abstract: A geonet of multiple layer structure according to the present invention has the improved ground reinforcing function, and thus can be applied to slope reinforcement or stabilization of a landfill final cover that requires both of a drainage performance and a reinforcing function.

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Description

GEONET OF MULTIPLE LAYER STRUCTURE USED IN ENGINEERING WORKS, APPARATUS FOR MANUFACTURING THE SAME, AND METHOD FOR MANUFACTURING THE SAME

Technical Field

- [1] The present invention relates to a geonet of multiple layer structure used in engineering works, an apparatus for manufacturing the same, and a method for manufacturing the same, and in particular, to a geonet of multiple layer structure, which includes a reinforcing fiber to improve a ground reinforcing function, an apparatus for manufacturing the same, and a method for manufacturing the same.

Background Art

- [2] Generally, a geonet is used to improve a ground drainage performance, and is substituted for a conventional gravel drainage layer.
- [3] The geonet is manufactured by melting a polymer resin in an extruder using high temperature, and discharging the melted polymer resin through a die. For example, a geonet of double layer structure is manufactured by discharging polymer resins from an inner die and an outer die that rotate in opposite directions and joining the polymer resin discharged from the inner die with the polymer resin discharged from the outer die. FIG. 1 shows a geonet 10 of double layer structure manufactured by the above-mentioned method, and because the geonet 10 of double layer structure is manufactured by rotating the outer die and the inner die in opposite rotation, the geonet 10 of double layer structure has a diamond-shaped grid pattern.
- [4] The geonet has smaller thickness and more economical efficiency than a gravel drainage layer, and thus is applied to a landfill. When the geonet is applied to a landfill, the utility of space, i.e. landfill capacity can be considerably increased.
- [5] However, the geonet is effective in improving a ground drainage performance, but has a relatively small tensile strength, consequently is poor at ground reinforcement. Therefore, the conventional geonet has a limitation in application to slope reinforcement or stabilization of a landfill final cover that requires both of a drainage performance and a reinforcing function.

Disclosure of Invention

Technical Problem

- [6] The present invention is designed to solve the above-mentioned problems, and therefore it is an object of the present invention to provide a geonet of multiple layer structure, which is applicable to slope reinforcement or stabilization of a landfill final cover that requires both of a drainage performance and a reinforcing function, and apparatus and method for manufacturing the same.

Technical Solution

- [7] In order to achieve the above-mentioned objects, a geonet of multiple layer structure according to the present invention comprises a main member including reinforcing fibers arranged at a predetermined interval and having an elongated shape in a lengthwise direction, and a polymer resin covering the reinforcing fibers; and diagonal members joined diagonally at a predetermined interval to a front or back surface of the main member, and made of a polymer resin.
- [8] And, a geonet of multiple layer structure according to the present invention comprises a main member including reinforcing fibers arranged at a predetermined interval and having an elongated shape in a lengthwise direction, and a polymer resin covering the reinforcing fibers; and diagonal members joined diagonally at a predetermined interval to a front surface and a back surface of the main member, and made of a polymer resin.
- [9] Preferably, the main member has thickness between 2 mm and 10 mm.
- [10] Preferably, an angle between the main member and the diagonal member is between 10 degrees and 80 degrees.
- [11] Preferably, the polymer resin is any one selected from the group consisting of a polyolefin-based resin, polyethylene terephthalate, polyamides, polyacrylates, polyacrylonitrile, polycarbonates, polyvinylchloride, polystyrene and polybutadiene, or combinations thereof.
- [12] Preferably, the reinforcing fiber is at least one selected from the group consisting of a polyester high tenacity yarn, a nylon fiber, a glass fiber, an aramide fiber, a carbon fiber, a stainless steel fiber, a copper fiber and an amorphous metal fiber.
- [13] A method for manufacturing a geonet of multiple layer structure according to another aspect of the present invention comprises providing a reinforcing fiber and a polymer resin; manufacturing a geonet by discharging a main member having the reinforcing fiber covered with the polymer resin through a central outlet, discharging diagonal members made of the polymer resin through an inner outlet and an outer outlet, and fixing the central outlet and rotating the outer outlet and the inner outlet in opposite directions to join the diagonal members diagonally joined to a front surface and a back

surface of the main member; and cooling the geonet.

- [14] And, a method for manufacturing a geonet of multiple layer structure, comprises providing a reinforcing fiber and a polymer resin; manufacturing a geonet by discharging a main member having the polymer resin covered with the reinforcing fiber through a central outlet, discharging a diagonal member made of the polymer resin through an inner outlet, and fixing the central outlet and rotating the inner outlet to join the diagonal member diagonally to a back surface of the main member; and cooling the geonet.
- [15] Further, a method for manufacturing a geonet of multiple layer structure comprises providing a reinforcing fiber and a polymer resin; manufacturing a geonet by discharging a main member having the polymer resin covered with the reinforcing fiber through a central outlet, discharging a diagonal member made of the polymer resin through an outer outlet, and fixing the central outlet and rotating the outer outlet to join the diagonal member diagonally to a front surface of the main member; and cooling the geonet.
- [16] Here, the central outlet has a circular arrangement, consequently the geonet has a cylindrical shape, and preferably the geonet manufacturing method cuts the geonet in the direction of discharge while cooling the geonet such that the geonet is changed from a cylindrical shape to a plane shape.
- [17] The geonet manufacturing method further comprises compressing the geonet of a plane shape after cooling the geonet.
- [18] An apparatus for manufacturing a geonet of multiple layer structure according to yet another aspect of the present invention comprises a providing unit for providing a reinforcing fiber; an extruding unit for extruding diagonal members made of a melted polymer resin and a main member having the reinforcing fiber covered with a melted polymer resin to manufacture a geonet; and a cooling unit for cooling the geonet discharged from the extruding unit, wherein the extruding unit includes a central die having a central outlet for discharging the main member; an inner die installed rotatably in the central die, and having an inner outlet located adjacent to the central outlet for discharging the diagonal member; and an outer die installed rotatably outside of the central die, and having an outer outlet located adjacent to the central outlet for discharging the diagonal member, and wherein each of the inner die and the outer die rotates to discharge the diagonal member, and the geonet is manufactured such that the diagonal member discharged from the inner outlet and the diagonal member discharged from the outer outlet are joined to the main member discharged from the

central outlet.

- [19] And, an apparatus for manufacturing a geonet of multiple layer structure comprises a providing unit for providing a reinforcing fiber; an extruding unit for extruding a diagonal member made of a melted polymer resin and a main member having the reinforcing fiber covered with a melted polymer resin to manufacture a geonet; and a cooling unit for cooling the geonet discharged from the extruding unit, wherein the extruding unit includes a central die having a central outlet for discharging the main member; and an inner die installed rotatably outside of the central die, and having an outer outlet located adjacent to the central outlet for discharging the diagonal member; and wherein the inner die rotates to discharge the diagonal member, and the geonet is manufactured such that the diagonal member discharged from the inner outlet is joined to the main member discharged from the central outlet.
- [20] Further, an apparatus for manufacturing a geonet of multiple layer structure comprises a providing unit for providing a reinforcing fiber; an extruding unit for extruding a diagonal member made of a melted polymer resin and a main member having the reinforcing fiber covered with a melted polymer resin to manufacture a geonet; and a cooling unit for cooling the geonet discharged from the extruding unit, wherein the extruding unit includes a central die having a central outlet for discharging the main member; and an outer die installed rotatably in the central die, and having an inner outlet located adjacent to the central outlet for discharging the diagonal member; wherein the geonet is manufactured such that the diagonal member is discharged by rotating the outer die, and the diagonal member discharged from the outer outlet is joined to the main member discharged from the central outlet.
- [21] Preferably, the central die and the inner die are installed in contact with each other, and a contact surface of the inner outlet with the central die is formed inward so that the diagonal member is discharged from the inner die.
- [22] Preferably, the central die and the outer die are installed in contact with each other, and a contact surface of the outer outlet with the central die is formed inward so that the diagonal member is discharged from the outer outlet.
- [23] Here, the extruding unit has a nipple member which the reinforcing fiber flows into and communicates with the central outlet, the providing unit has a guider for guiding the reinforcing fiber to the nipple member, and the reinforcing fiber flowed into the nipple member by the guider is covered with the polymer resin while moving downward, and discharged through the central outlet.
- [24] And, the apparatus for manufacturing a geonet of multiple layer structure further

comprises a compression roller unit installed at the rear of the cooling unit for compressing the cooled geonet; and a winding unit installed at the rear of the compression roller unit for winding the geonet, wherein a thermal contraction ratio of the reinforcing fiber is controlled by interworking with and rotating a providing roller of the providing unit, a compression roller of the compression roller unit and a winding roller of the winding unit.

[25] Further, the apparatus for manufacturing a geonet of multiple layer structure further comprises a cutter member for cutting the geonet discharged from the extruding unit in the direction of discharge to change the geonet of a cylindrical shape into a plane shape.

[26] Preferably, the inner die and the outer die rotate in opposite directions.

Brief Description of the Drawings

[27] FIG. 1 is a view illustrating a conventional geonet of double layer structure.

[28] FIG. 2 is a view illustrating a geonet of three layer structure according to the present invention.

[29] FIG. 3 is a cross-sectional view of the geonet of three layer structure of FIG. 2.

[30] FIG. 4 is a view illustrating a geonet of double layer structure according to the present invention.

[31] FIG. 5 is a view illustrating main components of an apparatus for manufacturing the geonet of FIG. 5.

[32] FIG. 6 is a cross-sectional view of an extruding unit of the apparatus of FIG. 2.

[33] FIG. 7 is an enlarged view of section A of FIG. 6.

[34] FIG. 8 is a cross-sectional view illustrating an outer die, a central die and an inner die of the extruding unit of FIG. 6.

[35] FIG. 9 is an enlarged view of section B of FIG. 8.

[36] FIG. 10 is a view illustrating main components of a system for measuring a co-efficient of horizontal permeability of a geonet manufactured according to the present invention.

Best Mode for Carrying Out the Invention

[37] Hereinafter, preferred embodiments of the present invention will be described in detail with reference to the accompanying drawings. Prior to the description, it should be understood that the terms used in the specification and the appended claims should not be construed as limited to general and dictionary meanings, but interpreted based on the meanings and concepts corresponding to technical aspects of the present

invention on the basis of the principle that the inventor is allowed to define terms appropriately for the best explanation. Therefore, the description proposed herein is just a preferable example for the purpose of illustrations only, not intended to limit the scope of the invention, so it should be understood that other equivalents and modifications could be made thereto without departing from the spirit and scope of the invention.

[38] FIG. 2 is a view illustrating a geonet of three layer structure according to the present invention, and FIG. 3 is a cross-sectional view of the geonet of three layer structure. Meanwhile, a geonet may have three layer structure or double layer structure. A 'geonet of multiple layer structure' in the present specification includes a geonet 3 of three layer structure and a geonet (5 of FIG. 4) of double layer structure. However, for convenience of description, the present invention is hereinafter described based on the geonet 3 of three layer structure.

[39] Referring to FIGs. 2 and 3, the geonet 3 of three layer structure comprises main members 3a and diagonal members 3b joined to the main members 3a diagonally.

[40] The main member 3a includes reinforcing fibers 1 arranged at a predetermined interval and a polymer resin 2 covering the reinforcing fibers 1. The reinforcing fiber 1 increases a tensile strength of the geonet 3 of three layer structure. The reinforcing fiber 1 may include a polyester high tenacity yarn, a glass fiber, an aramide fiber, a carbon fiber, a stainless steel fiber, a copper fiber or an amorphous metal fiber.

[41] Preferably, an arrangement interval (λ) between the main members 3a is between 3 mm and 30 mm, more preferably between 10 mm and 25 mm. And, preferably the reinforcing fiber 1 has thickness of 3 mm or less.

[42] In the case that the arrangement interval (λ) between the main members 3a is less than 3 mm, a space of a channel through which fluid flows is small, consequently the plane flow is poor, and in the case that the arrangement interval (λ) between the main members 3a is more than 30 mm, the parallel reinforcing fibers 1 are arranged with a small quantity to remarkably reduce a reinforcing function, and when a polymer resin is diagonally joined to a front surface and a back surface of the main member 3a, the shape stability between the polymer resin and the main member 3a is not good.

[43] The polymer resin 2 covers the reinforcing fiber 1. The polymer resin 2 may be any one selected from the group consisting of a polyolefin-based resin, polyethylene terephthalate (PET), polyamides, polyacrylates, polyacrylonitrile, polycarbonates, polyvinylchloride (PVC), polystyrene and polybutadiene, or combinations thereof.

[44] Preferably, the polymer resin 2 containing the reinforcing fiber 1 therein has the entire thickness (P1) between 2 mm and 10 mm and the entire width (S1) between 1 mm

and 8 mm. In the case that the thickness (P1) of the polymer resin 2 is less than 2 mm, a horizontal drainage performance is low, and in the case that the thickness (P1) of the polymer resin 2 is more than 10 mm, an economical efficiency is remarkably reduced due to increase in quantity of a polymer resin provided from an extruding unit, and a cross section of the polymer resin is expanded before the polymer resin is cooled, so that the polymer resin can not maintain its unique cross section. The arrangement interval (x) between the main members 3a and the thickness (P1) of the polymer resin 2 are main factors for determining a horizontal drainage performance.

[45] The diagonal members 3b are diagonally joined to a front surface and a back surface of the main member 3a. The diagonal member 3b is made of the polymer resin 2. The polymer resin 2 of the diagonal member 3b and the polymer resin 2 of the main member 3a are extruded by the same extruding unit, and thus the diagonal member 3b is made of the same material as the main member 3a. The extruding unit is described later.

[46] Preferably, the diagonal member 3b has width (S2, S3) between 0.5 mm and 5 mm and thickness (P2, P3) between 0.5 mm and 10 mm. In the case that the width (S2, S3) of the diagonal member 3b is less than 0.5 mm and the thickness (P2, P3) of the diagonal member 3b is less than 0.5 mm, the plane flow of fluid is remarkably reduced, consequently a horizontal drainage performance is reduced, and in the case that the width (S2, S3) of the diagonal member 3b is more than 5 mm and the thickness (P2, P3) of the diagonal member 3b is more than 10 mm, an economical efficiency is remarkably reduced due to increase in quantity of a polymer resin provided from the extruding unit.

[47] And, preferably an angle (θ_1 , θ_2) between the diagonal member 3b and the main member 3a is between 10 degrees and 80 degrees, more preferably between 30 degrees and 60 degrees. In the case that the angle (θ_1 , θ_2) between the diagonal member 3b and the main member 3a is less than 10 degrees, rotation speed of an inner die and an outer die is reduced, consequently a geonet production speed is remarkably reduced, and in the case that the angle (θ_1 , θ_2) between the diagonal member 3b and the main member 3a is more than 80 degrees, rotation speed of an inner die and an outer die is relatively increased, consequently a geonet product is not manufactured in a uniform shape.

[48] Meanwhile, although this embodiment shows a geonet of three layer structure having the diagonal members 3b joined to both of a front surface and a back surface of the main member 3a, the present invention may manufacture a geonet of double layer

structure, in which the diagonal member 3b is joined to either a front surface or a back surface of the main member 3a. FIG. 4 is a view illustrating a geonet 5 of double layer structure. An ordinary person skilled in the art can easily understand the geonet 5 of double layer structure from the geonet 3 of three layer structure, and description of the geonet 5 of double layer structure is omitted.

[49] Hereinafter, a method for manufacturing a geonet of multiple layer structure is described. For convenience of description, the method is described based on the geonet 3 of three layer structure.

[50] The method for manufacturing the geonet 3 of three layer structure comprises providing the reinforcing fiber 1 and the polymer resin 2 to an extruding unit; manufacturing the geonet 3 by joining the reinforcing fiber 1 with the polymer resin 2 while discharging the polymer resin 2 and the reinforcing fiber 1 covered with the polymer resin 2 from the extruding unit; cutting the geonet discharged from the extruding unit while cooling the geonet; compressing the cooled geonet 3; and winding the compressed geonet 3. Each step of the method may be performed by an apparatus (100 of FIG. 5) for manufacturing a geonet. Therefore, the geonet manufacturing method is described together with the apparatus 100 for manufacturing a geonet.

[51] FIG. 5 is a view illustrating main components of an apparatus for manufacturing a geonet according to the present invention, FIG. 6 is a cross-sectional view of an extruding unit of the apparatus, and FIG. 7 is an enlarged view of section A of FIG. 6.

[52] Referring to FIGs. 5 to 7, the geonet manufacturing apparatus 100 comprises a providing unit 20 for providing the reinforcing fiber 1; an extruding unit 30 for extruding the diagonal member 3b made of the melted polymer resin 2 and the main member 3a having the reinforcing fiber 1 covered with the melted polymer resin 2 to manufacture the geonet 3; a cooling unit 40 for cooling the geonet 3 discharged from the extruding unit 30; a compression roller unit 50 for compressing the geonet 3; and a winding unit 60 for winding the geonet 3.

[53] The providing unit 20 provides the reinforcing fiber 1 to the extruding unit 30. The providing unit 20 includes providing rollers 22, and a guider 24 for guiding the reinforcing fiber 1 moved from the providing rollers 22 to nipple members 34 of the extruding unit 30. The providing roller 22 and the guider 24 are installed on a support 90.

[54] The providing rollers 22 feed the guider 24 with the reinforcing fiber 1 moved from a reinforcing fiber winding roller (not shown). The providing rollers 22 are a pair of rollers installed facing each other, and because the reinforcing fiber 1 is fed between a

pair of the providing rollers 22, the providing rollers 22 can control a feeding speed of the reinforcing fiber 1.

[55] The guider 24 guides the reinforcing fiber 1 to the nipple member 34 arranged such that the reinforcing fiber 1 has a cylindrical shape.

[56] The extruding unit 30 includes a polymer resin provider 31 for providing the melted polymer resin 2; top dies 32 having the nipple members 34 installed therein; central dies 35 for discharging the reinforcing fiber 1 covered with the melted polymer resin 2, i.e. the main member 3a; inner dies 36 and outer dies 37 for discharging the melted polymer resin 2, i.e. the diagonal member 3b; and a first driving motor 38a and a second driving motor 39a for rotating the outer dies 37 and the inner dies 36, respectively.

[57] The polymer resin provider 31 melts the polymer resin 2 and provides the melted polymer resin 2 to storing units 32a. The polymer resin provider 31 includes heating members 31a for heating the polymer resin 2 to maintain the melted state of the polymer resin 2, and a passage through which the melted polymer resin 2 passes. The polymer resin 2 passed through the passage is stored into the storing units 32a formed between the top dies 32 and the central dies 35, and is discharged to the external through inner outlets 36a, outer outlets 37a, and central outlets 35a. An arrow 31b indicated as a dotted line in FIG. 6 is a movement path of the melted polymer resin 2.

[58] The top die 32 is installed on the central die 35, and has the nipple members 34, which the reinforcing fiber 1 flows into. The reinforcing fiber 1 flowed into the nipple member 34 is covered with the polymer resin 2 while passing through the storing unit 32a and the central outlet 35a, and discharged to the external.

[59] The central die 35 is installed fixedly under the top die 32. The central die 35 has the central outlet 35a, through which the main member 3a is discharged.

[60] The central outlet 35a, the inner outlet 36a and the outer outlet 37a may be formed in various shapes, for example rectangle, triangle, circle or oval shape. In particular, when forming the main member 3a and the diagonal member 3b in a specific shape, it is preferable to consider rotation of the outer die 37 and the inner die 35.

[61] In other words, the central outlet 35a may be formed in various shapes, for example rectangle or oval shape, however preferably the central outlet 35a is formed in the shape of a parallelogram as shown in FIG. 9. In the case that the central outlet 35a is formed in the shape of a parallelogram, the main member 3b discharged from the central outlet 35a has a parallelogram shape, and the main member 3b of a parallelogram shape is joined with the diagonal members 3b, thereby forming a rectangle

pattern. That is, the main member 3a discharged in the shape of a parallelogram is joined with the diagonal members 3b discharged from the outer outlet 37a and the inner outlet 36a that rotate in opposite directions, thereby forming a rectangle pattern due to a rotation force of the diagonal members 3b.

[62] The outer die 37 is rotatably installed outside of the central die 35. The outer die 37 is rotated by the first driving motor 38a. A driving force of the first driving motor 38a is transmitted to a first chain gear 38c by a first chain 38b, and the outer die 37 is connected to the first chain gear 38c, and thus is rotated together with the first chain gear 38c.

[63] The outer die 37 has the outer outlet 37a formed adjacent to the central outlet 35a. The outer outlet 37a discharges the melted polymer resin 2, i.e. the diagonal member 3b downward.

[64] As shown in FIGs. 7 to 9, preferably the outer outlet 37a has an inward contact surface with the central die 35. In this case, the diagonal member 3b is discharged through a space between the outer outlet 37a and the central die 35.

[65] The inner die 36 is installed rotatably in the central die 35. The inner die 36 is rotated by the second driving motor 39a, a second chain 39b, a second chain gear 39c and a shaft 39d. A driving force of the second driving motor 39a is transmitted to the inner die 36 through the second chain 39b, the second chain gear 39c and the shaft 39d. The inner die 36 is connected to the shaft 39d, and thus is rotated together with the shaft 39d.

[66] The inner die 36 has the inner outlet 36a formed adjacent to the central outlet 35a. The inner outlet 36a discharges the diagonal member 3b downward.

[67] Preferably, the inner outlet 36a has an inward contact surface with the central die 35. In this case, the diagonal member 3b is discharged through a space between the inner outlet 36a and the central die 35.

[68] The inner die 36 and the outer die 37 rotate in opposite directions. For example, when the inner die 36 rotates in a counterclockwise direction, the outer die 37 rotates in a clockwise direction. Therefore, as shown in FIG. 2, the diagonal member 3b discharged from the outer outlet 37a and the diagonal member 3b discharged from the inner outlet 36a are joined with each other in a crisscross pattern to form a diamond-shaped grid pattern, and the reinforcing fiber 1 covered with the polymer resin 2, i.e. the main member 3a is joined to the center of the grid. The polymer resin 2 discharged from the outer outlet 37a, i.e. the diagonal member 3b discharged from the outer outlet 37a is joined to a front surface of the reinforcing fiber 1, and the polymer resin 2

discharged from the inner outlet 36a, i.e. the diagonal member 3b discharged from the inner outlet 36a is joined to a back surface of the reinforcing fiber 1. That is, the extruding unit 30 includes the outer die 37, the central die 35 and the inner die 36, and thus can manufacture the geonet 3 of three layer structure.

- [69] The angle (θ_1 , θ_2) between the main member 3a and the diagonal member 3b is determined by a rotation speed of the inner die 36 and the outer die 37, and a discharge speed of the main member 3a, and preferably the angle (θ_1 , θ_2) is between 10 degrees and 80 degrees, more preferably between 30 degrees and 60 degrees.
- [70] The geonet 3 manufactured in the extruding unit 30 is cooled by the cooling unit 40. Preferably, the cooling unit 40 contains a cooling water for cooling the geonet 3. The cooled geonet 3 passes on guide rollers 45 and 46 and moves to the compression roller unit 50 and the winding unit 60.
- [71] Preferably, the cooling unit 40 has the cutter member 42 for cutting the geonet 3. The cutter member 42 cuts the geonet 3 in the direction of discharge from the extruding unit 30, so that the geonet 3 is changed from a cylindrical shape to a plane shape.
- [72] The compression roller unit 50 compresses the geonet 3, and the winding unit 60 winds the geonet 3 compressed by the compression roller unit 50 on a winding roller 62. As mentioned above, the reinforcing fiber 1 passed through the extruding unit 30 contracts thermally, and the thermal contraction can be controlled by interworking with and rotating the providing rollers 22, compression rollers 52 and the winding roller 62 by a controller (not shown) to control a tensile strength applied to the geonet 3. A reference numeral 54 is a rotating motor for rotating the compression rollers 52, and a reference numeral 64 is a winding motor for rotating the winding roller 62.
- [73] Meanwhile, this embodiment shows that the geonet 3 is manufactured by rotating the outer die 37 and the inner die 36 in opposite directions, however the present invention is not limited in this regard.
- [74] For example, according to the technical spirit of the present invention, the geonet manufacturing apparatus 100 may comprise only the outer die 37 and the central die 35 and manufacture a geonet of double layer structure by rotating the outer die 37, or the geonet manufacturing apparatus 100 may comprise only the inner die 36 and the central die 35 and manufacture a geonet (5 of FIG. 4) of double layer structure by rotating the inner die 36, which is obvious to a ordinary person skilled in the art. And, the geonet manufacturing system 100 of the present invention may manufacture a geonet 5 of double layer structure by stopping the operation of the inner die 36 or the outer die 37.

- [75] Next, the geonet 3 of three layer structure is compared with a general geonet based on tenacity, tensility and a coefficient of horizontal permeability as follows.
- [76] [Example 1]
- [77] The reinforcing fiber 1 uses a polyester high tenacity yarn of 8000 danier, and the polymer resin 2 uses a polypropylene resin. The interval (λ) between the reinforcing fibers 1, i.e. the interval (λ) between the main members 3a is 15 mm, the width (S1) of the main member 3a is 3 mm, and the thickness (P1) of the main member 3a is 5 mm. The inner die 36 and the outer die 37 rotate in opposite directions. The rotation speed of the inner die 36 and the outer die 37 each is 30 R.P.M. The width (S2, S3) of each polymer resin 2 discharged through the inner outlet 36a the outer outlet 37a, i.e. the width (S2, S3) of the diagonal member 3b is 2 mm, and the thickness (P2, P3) of the diagonal member 3b is 2 mm. The angle (θ_1, θ_2) between the main member 3a and the diagonal member 3b is 45 degrees.
- [78] The discharged geonet 3 is rapidly cooled while passing through the cooling water of normal temperature, and cut in the direction of discharge from the extruding unit 30, so that the geonet 3 is changed from a cylindrical shape to a plane shape. Subsequently, the geonet 3 is compressed by the compression roller unit 50 and wound by the winding unit 60.
- [79] The providing rollers 22, the compression rollers 52 and the winding roller 62 interwork with each other and operate such that a linear velocity ratio (angular velocity of roller $\times$ diameter of roller) is 1:1.2:1.2.
- [80] The tenacity, tensility and coefficient of horizontal permeability of the geonet 3 manufactured by the above-mentioned process were measured. The geonet 3 is prepared having 100 mm width and 200 mm length. The tenacity and tensility is measured by ASTM D 4595, and the coefficient of horizontal permeability is measured by ASTM D 4716.
- [81] As shown in FIG. 10, a water-head differential between two water tanks 81 and 82 is maintained with H, external pressures of 10, 15, 20, 25, 30, 35, 50, 100, 200 kN/m² are applied to the geonet 3 in sequence, and a coefficient of horizontal permeability is calculated by converting a movement amount of water with time. A reference numeral 84 is a loading plate, and 85 is a base plate.
- [82] An equation for calculating the coefficient of horizontal permeability is as follows.
- [83] MathFigure 1

[Math.1]

Coefficient of horizontal permeability(k)(unit: m²/s) = (QL)/(WH)

[84] where Q is an amount of moved water per unit time, L is length of a sample, W is width of a sample, H is a water-head differential.

[85] [Example 2]

[86] The example 2 is the same as the example 1 except that the example 2 uses a polyester high tenacity yarn of 4000 danier as the reinforcing fiber 1.

[87] [Example 3]

[88] The rotation speed of the inner die 36 and the outer die 37 each is 15 R.P.M, and the angle (θ1, θ2) between the main member 3a and the diagonal member 3b is 30 degrees. The other conditions are the same as those of the example 1.

[89] [Comparative example 1]

[90] The comparative example 1 is the same as the example 1 except that the comparative example 1 does not use the reinforcing fiber 1.

[91] [Comparative example 2]

[92] The reinforcing fiber 1 uses a polyester high tenacity yarn of 16000 danier, and the polymer resin 2 uses a polypropylene resin. The interval (x) of the main members 3a is 32 mm. The other conditions are the same as those of the example 1.

[93] [Comparative example 3]

[94] The reinforcing fiber 1 uses a polyester high tenacity yarn of 8000 danier, and the polymer resin 2 uses a polypropylene resin. The interval (x) of the main members 3a is 15 mm, the width (S1) of the main member 3a is 0.8 mm, and the thickness (P1) of the main member 3a is 1.5 mm.

[95] Table 1

[Table 1]

[Table]

	Tenacity (kN/m)	Tensility (%)	Coefficient of horizontal permeability (m ² /sec)
Example 1	45	12.0	3.6×10^{-3}
Example 2	23	12.1	3.3×10^{-3}
Example 3	43	12.4	3.7×10^{-3}
Comparative example 1	3	13.0	2.8×10^{-3}
Comparative example 2	42	12.2	6.1×10^{-5}
Comparative example 3	40	11.9	4.3×10^{-5}

Industrial Applicability

- [96] The geonet of multiple layer structure according to the present invention has the remarkably improved ground reinforcing function than a conventional geonet. Therefore, the geonet of the present invention can be applied to slope reinforcement or stabilization of a landfill final cover that requires both of a drainage performance and a reinforcing function.

Claims

- [1] A geonet of multiple layer structure, comprising:
a main member including reinforcing fibers arranged at a predetermined interval and having an elongated shape in a lengthwise direction, and a polymer resin covering the reinforcing fibers; and
diagonal members joined diagonally at a predetermined interval to a front or back surface of the main member, and made of a polymer resin.
- [2] A geonet of multiple layer structure, comprising:
a main member including reinforcing fibers arranged at a predetermined interval and having an elongated shape in a lengthwise direction, and a polymer resin covering the reinforcing fibers; and
diagonal members joined diagonally at a predetermined interval to a front surface and a back surface of the main member, and made of a polymer resin.
- [3] The geonet of multiple layer structure according to claim 1 or 2,
wherein the main member has thickness between 2 mm and 10 mm.
- [4] The geonet of multiple layer structure according to claim 1 or 2,
wherein an angle between the main member and the diagonal member is between 10 degrees and 80 degrees.
- [5] The geonet of multiple layer structure according to claim 1 or 2,
wherein the polymer resin is any one selected from the group consisting of a polyolefin-based resin, polyethylene terephthalate, polyamides, polyacrylates, polyacrylonitrile, polycarbonates, polyvinylchloride, polystyrene and polybutadiene, or combinations thereof.
- [6] The geonet of multiple layer structure according to claim 1 or 2,
wherein the reinforcing fiber is at least one selected from the group consisting of a polyester high tenacity yarn, a nylon fiber, a glass fiber, an aramide fiber, a carbon fiber, a stainless steel fiber, a copper fiber and an amorphous metal fiber.
- [7] A method for manufacturing a geonet of multiple layer structure, the method comprising:
providing a reinforcing fiber and a polymer resin;
manufacturing a geonet by discharging a main member having the reinforcing fiber covered with the polymer resin through a central outlet, discharging diagonal members made of the polymer resin through an inner outlet and an outer outlet, and fixing the central outlet and rotating the outer outlet and the

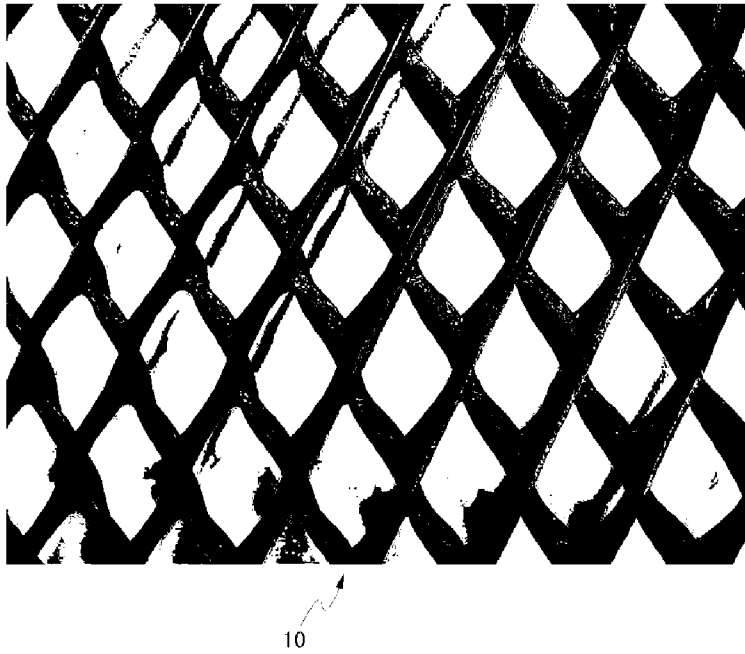
inner outlet in opposite directions to join the diagonal members diagonally to a front surface and a back surface of the main member; and
cooling the geonet.

- [8] A method for manufacturing a geonet of multiple layer structure, the method comprising:
providing a reinforcing fiber and a polymer resin;
manufacturing a geonet by discharging a main member having the polymer resin covered with the reinforcing fiber through a central outlet, discharging a diagonal member made of the polymer resin through an inner outlet, and fixing the central outlet and rotating the inner outlet to join the diagonal member diagonally to a back surface of the main member; and
cooling the geonet.
- [9] A method for manufacturing a geonet of multiple layer structure, the method comprising:
providing a reinforcing fiber and a polymer resin;
manufacturing a geonet by discharging a main member having the polymer resin covered with the reinforcing fiber through a central outlet, discharging a diagonal member made of the polymer resin through an outer outlet, and fixing the central outlet and rotating the outer outlet to join the diagonal member diagonally to a front surface of the main member; and
cooling the geonet.
- [10] An apparatus for manufacturing a geonet of multiple layer structure, the apparatus comprising:
a providing unit for providing a reinforcing fiber;
an extruding unit for extruding diagonal members made of a melted polymer resin and a main member having the reinforcing fiber covered with a melted polymer resin to manufacture a geonet; and
a cooling unit for cooling the geonet discharged from the extruding unit,
wherein the extruding unit includes:
a central die having a central outlet for discharging the main member;
an inner die installed rotatably in the central die, and having an inner outlet located adjacent to the central outlet for discharging the diagonal member; and
an outer die installed rotatably outside of the central die, and having an outer outlet located adjacent to the central outlet for discharging the diagonal member,
and

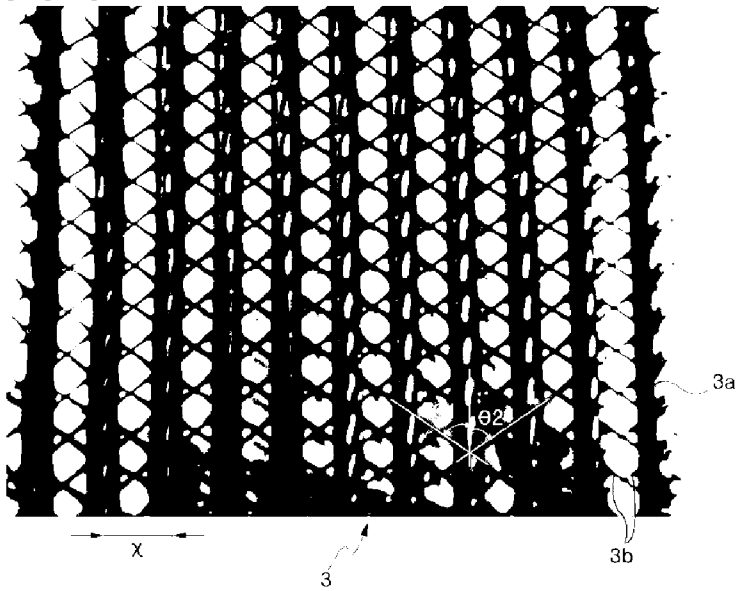
- wherein each of the inner die and the outer die rotates to discharge the diagonal member, and the geonet is manufactured such that the diagonal member discharged from the inner outlet and the diagonal member discharged from the outer outlet are joined to the main member discharged from the central outlet.
- [11] An apparatus for manufacturing a geonet of multiple layer structure, the apparatus comprising:
- a providing unit for providing a reinforcing fiber;
 - an extruding unit for extruding a diagonal member made of a melted polymer resin and a main member having the reinforcing fiber covered with a melted polymer resin to manufacture a geonet; and
 - a cooling unit for cooling the geonet discharged from the extruding unit,
- wherein the extruding unit includes:
- a central die having a central outlet for discharging the main member; and
 - an inner die installed rotatably in the central die, and having an inner outlet located adjacent to the central outlet for discharging the diagonal member;
- wherein the inner die rotates to discharge the diagonal member, and the geonet is manufactured such that the diagonal member discharged from the inner outlet is joined to the main member discharged from the central outlet.
- [12] An apparatus for manufacturing a geonet of multiple layer structure, the apparatus comprising:
- a providing unit for providing a reinforcing fiber;
 - an extruding unit for extruding a diagonal member made of a melted polymer resin and a main member having the reinforcing fiber covered with a melted polymer resin to manufacture a geonet; and
 - a cooling unit for cooling the geonet discharged from the extruding unit,
- wherein the extruding unit includes:
- a central die having a central outlet for discharging the main member; and
 - an outer die installed rotatably outside of the central die, and having an outer outlet located adjacent to the central outlet for discharging the diagonal member;
- wherein the outer die rotates to discharge the diagonal member, and the geonet is manufactured such that the diagonal member discharged from the outer outlet is joined to the main member discharged from the central outlet.
- [13] The apparatus for manufacturing a geonet of multiple layer structure according to claim 10 or 11,
- wherein the central die and the inner die are installed in contact with each other,

- and a contact surface of the inner outlet with the central die is formed inward so that the diagonal member is discharged from the inner outlet.
- [14] The apparatus for manufacturing a geonet of multiple layer structure according to claim 10 or 12,
wherein the central die and the outer die are installed in contact with each other, and a contact surface of the outer outlet with the central die is formed inward so that the diagonal member is discharged from the outer outlet.
- [15] The apparatus for manufacturing a geonet of multiple layer structure according to any one of claims 10 to 12,
wherein the extruding unit has a nipple member which the reinforcing fiber flows into and communicates with the central outlet,
wherein the providing unit has a guider for guiding the reinforcing fiber to the nipple member, and
wherein the reinforcing fiber flowed into the nipple member by the guider is covered with the polymer resin while moving downward, and discharged through the central outlet.
- [16] The apparatus for manufacturing a geonet of multiple layer structure according to any one of claims 10 to 12, further comprising:
a compression roller unit installed at the rear of the cooling unit for compressing the cooled geonet; and
a winding unit installed at the rear of the compression roller unit for winding the geonet,
wherein a thermal contraction ratio of the reinforcing fiber is controlled by interworking with and rotating a providing roller of the providing unit, a compression roller of the compression roller unit and a winding roller of the winding unit.
- [17] The apparatus for manufacturing a geonet of multiple layer structure according to any one of claims 10 to 12, further comprising:
a cutter member for cutting the geonet discharged from the extruding unit in the direction of discharge to change the geonet of a cylindrical shape into a plane shape.
- [18] The apparatus for manufacturing a geonet of multiple layer structure according to claim 10,
wherein the inner die and the outer die rotate in opposite directions.

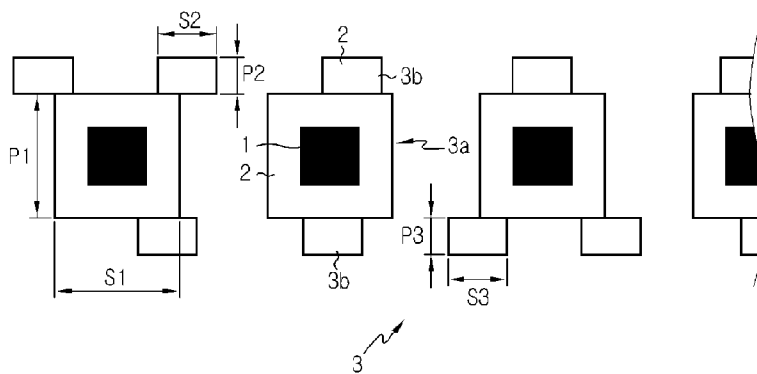
[Fig. 1]



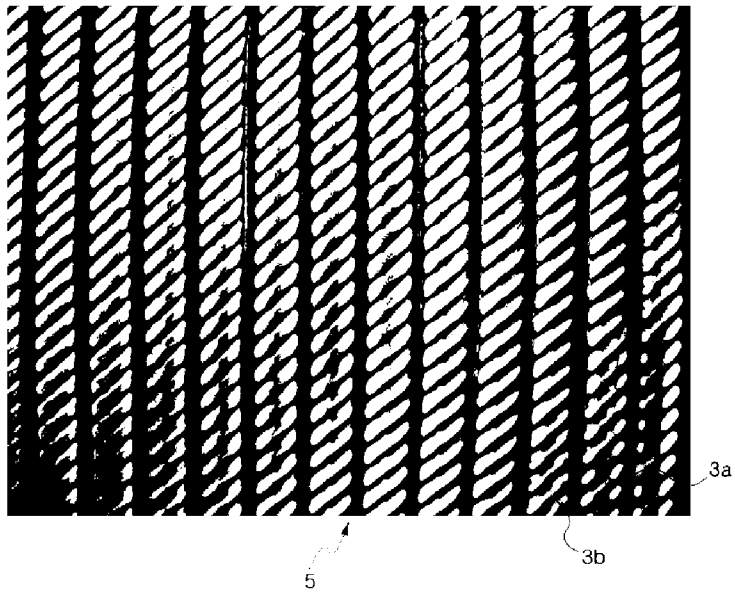
[Fig. 2]



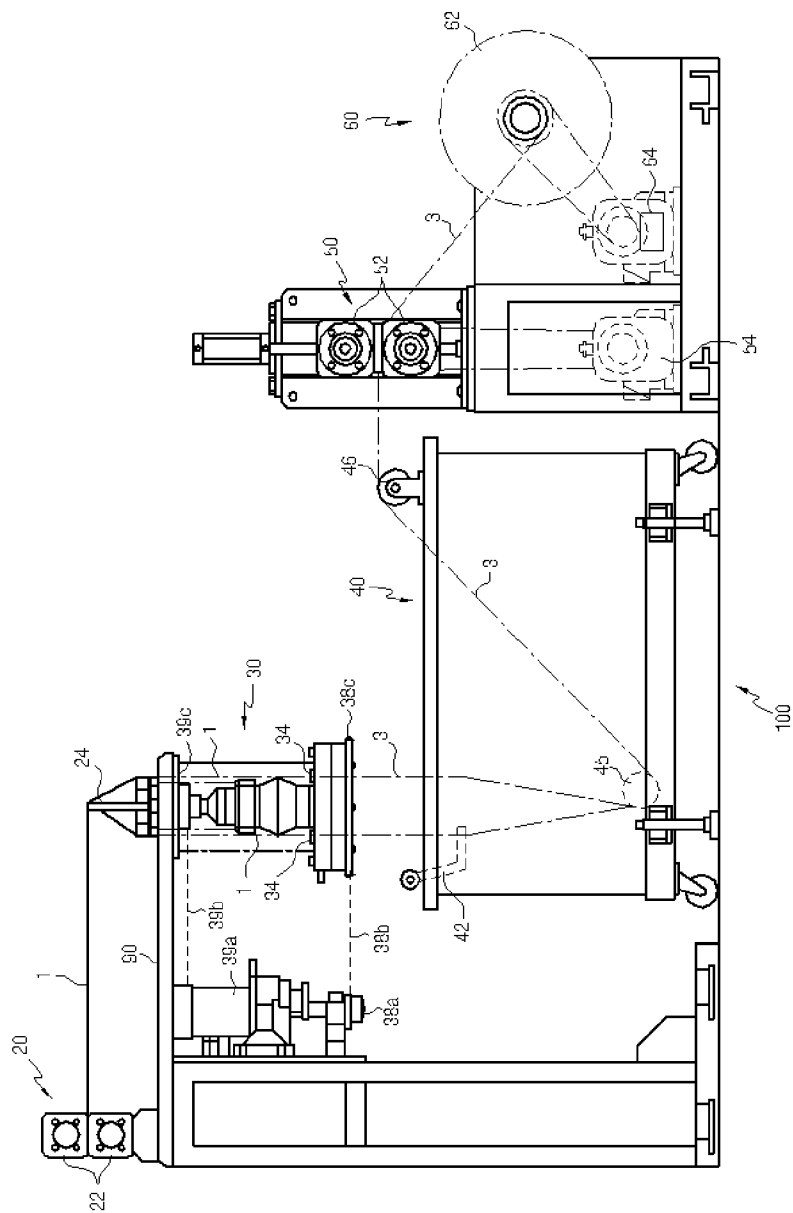
[Fig. 3]



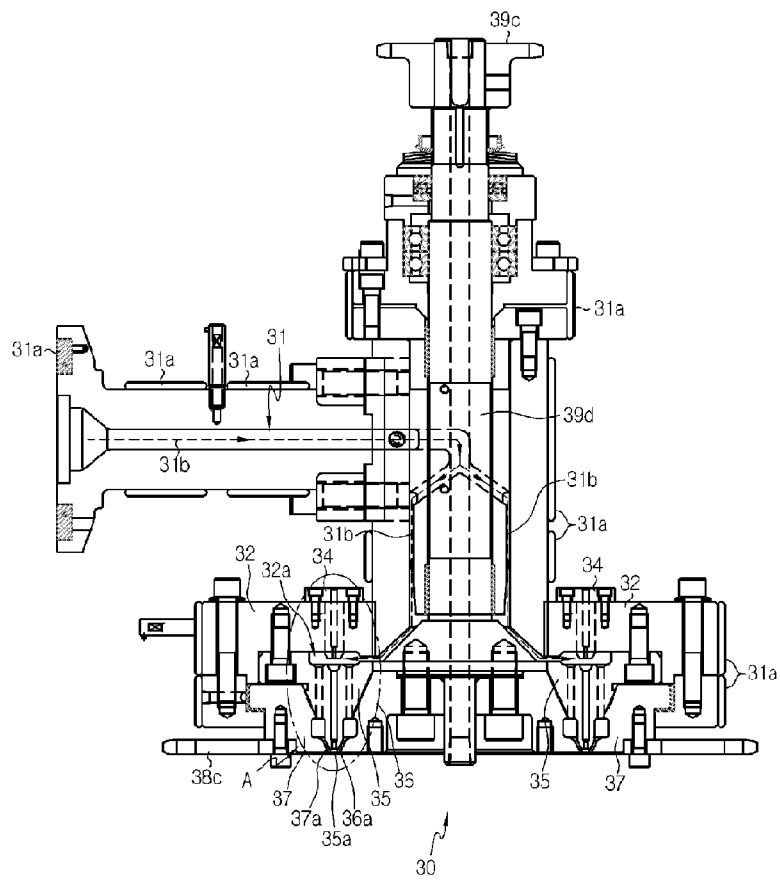
[Fig. 4]



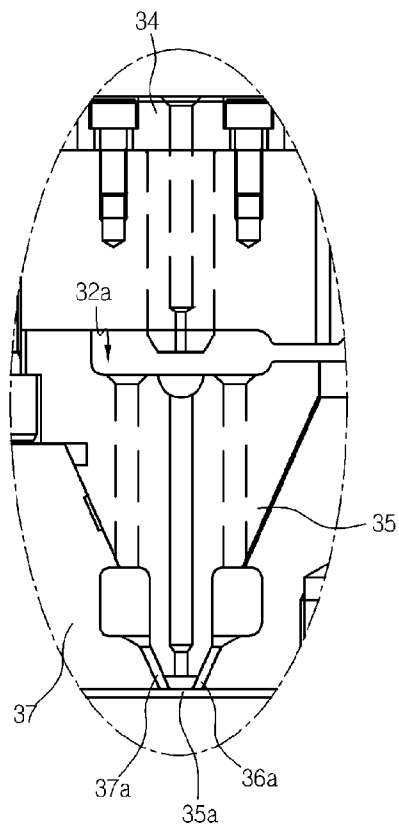
[Fig. 5]



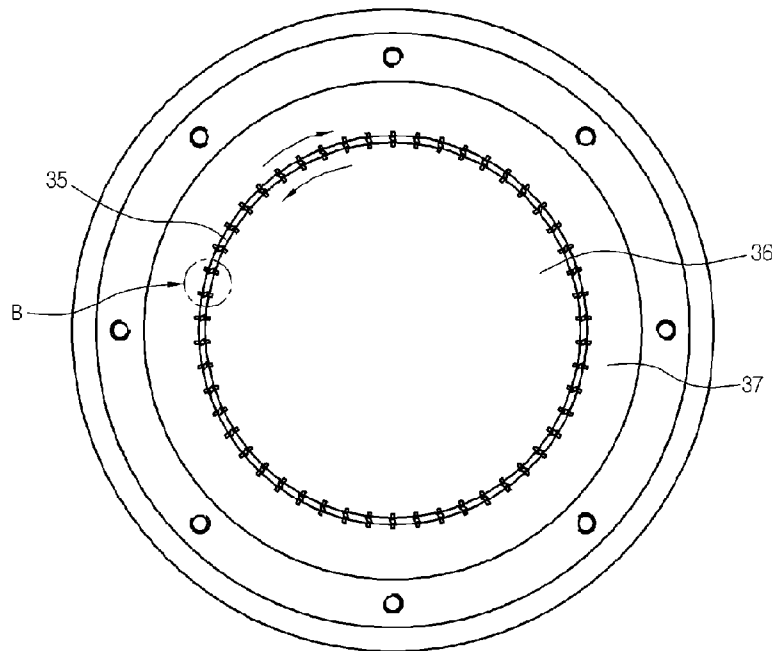
[Fig. 6]



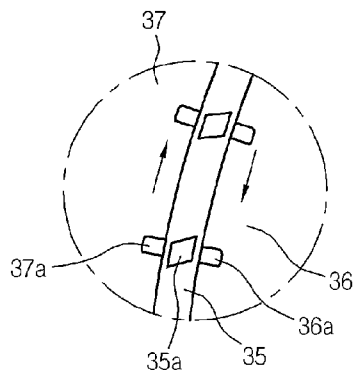
[Fig. 7]



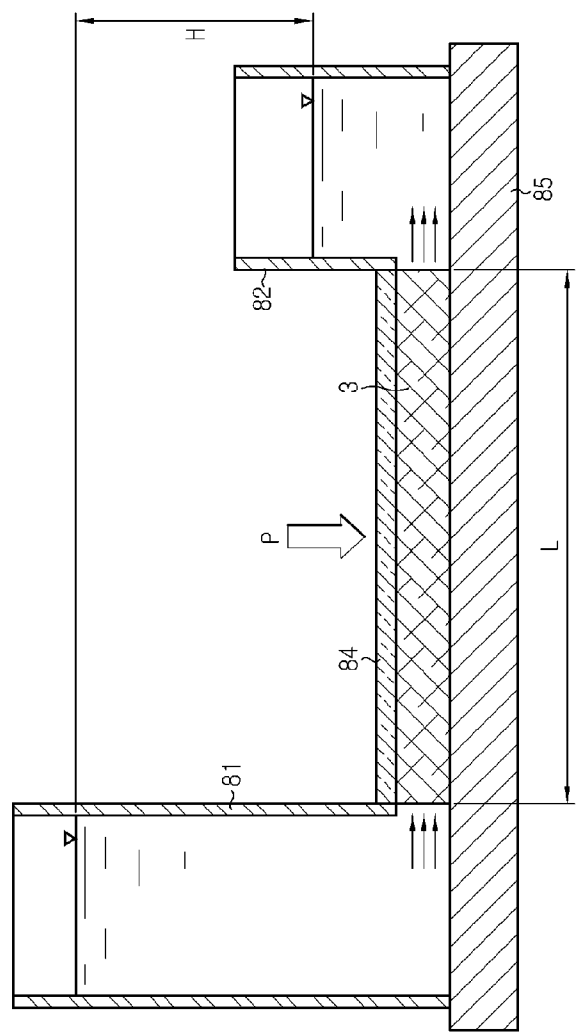
[Fig. 8]



[Fig. 9]



[Fig. 10]



INTERNATIONAL SEARCH REPORT

International application No.
PCT/KR2007/004646**A. CLASSIFICATION OF SUBJECT MATTER****E02D 31/02(2006.01)i, B09B 1/00(2006.01)i**

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 8 : E02D 31/02

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Korean Utility models : IPC as above

Japanese Utility models : IPC as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

eKIPASS(KIPO) : "geonet, layer, manufacture, fiber, reinforced, polymer, resin, strand"

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	EP 0512752 A1 (NETLON LIMITED) 11 November 1992 See the abstract, column (6,7) and figure 6	1 - 6
Y	KR 10-2004-0058611 A (SAMYANG CORPORATION) 5 July 2004 See the abstract, page 3, claims 1 - 18 and figure 1	1 - 6
A	EP 1785262 A1 (GSE LINING TECHNOLOGY INC.) 16 May 2007 See the abstract, figures 4 - 6	1 - 18
A	EP 0259165 A2 (LEUCADIA INC.) 9 March 1988 See the abstract, figures 1, 4 - 10	1 - 18
A	KR 10-2005-0070384 A (SAMYANG CORPORATION) 7 July 2005 See the abstract, page 5, claims 1 - 25 and figures 1 - 5	1 - 18

☐ Further documents are listed in the continuation of Box C.☒ See patent family annex.

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Date of the actual completion of the international search

26 FEBRUARY 2008 (26.02.2008)

Date of mailing of the international search report

26 FEBRUARY 2008 (26.02.2008)

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

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