

INTERLOCKABLE PANEL AND MULTILAYER PANEL STRUCTURE

Field of the Invention

This invention relates to an interlockable panel adapted for use to engage with other panels to form a multilayer panel structure to be installed underground for promoting tree root growth, managing stormwater runoff, and supporting hardscape/softscape areas, or to form a pallet for storing and transporting goods.

Background of the Invention

In landscaping and gardening activities, hardscape (e.g. walkways, driveways, concrete patios, water features, parking areas, etc.) and softscape (e.g. trees, flowers, grasses, vegetation, etc.) are often used to make our environment more aesthetically pleasing and healthy living. However, in order to keep the hardscape/softscape in place and to prevent any damage to them due to poor soil structure, a strong support system that acts as a stable base with a high loading capacity to support the hardscape/softscape above is desired.

Growing big healthy trees in urban areas is increasingly difficult due to lack of open space. Hence, in urban areas, trees are commonly planted next to the sidewalk/roadway or within small openings in the sidewalk/roadway. As trees grow, tree roots would grow and extend against the sidewalk/roadway which may cause damages to the sidewalk/roadway. Furthermore, a firm and compacted soil is required to support the heavy sidewalk/roadway which will impede the growth of the tree roots. Hence, in order to resolve the above issues, a tree root protection system that enables tree roots to grow freely and healthily with sufficient oxygen and moisture is desired.

Controlling and managing stormwater runoff is another problem in urban areas. A good stormwater management system would be able to collect excessive runoff water, filter the runoff water by removing trashes and big particles, and slowly discharge the runoff water to public drains. Due to high cost and space constraints, a conventional concrete stormwater treatment facility is not a good option. Hence, a cost effective and easy to implement

stormwater management system that can be installed in urban and flood-prone areas or underneath hardscape/softscape is highly desired.

In view of the above, there exists the need for a scalable, efficient, scalable, cost effective, and easy to implement system that can accommodate all the requirements for a strong base support, tree root protection, and stormwater runoff management.

Summary of the Invention

The above and other problems are solved and an advance in the art is made by provision of an interlockable panel which can be used to form a scalable multilayer panel structure for supporting hardscape/softscape areas, promoting tree root growth, and managing stormwater runoff, or to form a pallet for storing and transporting goods.

Due to its functional design and material used, the panel of this invention has many advantages including the following aspects. The panel is environmentally friendly, lightweight, strong, durable, reusable, cost effective, high loading capacity, and easy to install. A multilayer panel structure formed by the panels with vertical support columns can be used to accommodate all the requirements for supporting hardscape/softscape areas, promoting healthy tree root growth, and managing stormwater runoff in urban areas. Importantly, the multilayer panel structure is able to provide multiple connection options with the support columns thereby allowing to reduce the number of support columns to be used, and thus reducing the material cost and installation cost of the multilayer panel structure significantly. Due to the modular feature and efficient interlocking mechanism of the panel, the multilayer panel structure is scalable to any size and can be installed/disassembled easily without any additional attachments or tools. Furthermore, a simple pallet can be formed by two (or more) interlocked panels attached with suitable support legs for storing goods and movable by forklift.

In accordance with embodiments of this invention, a panel is provided. The panel comprising: (a) a top surface, a bottom surface opposing the top surface, a boundary wall extending from a perimeter edge of the top surface to a perimeter edge of the bottom surface defining a main body comprising an outer body section and an inner body section enclosed

by the outer body section, wherein the boundary wall having two parallel length sides and two parallel width sides; (b) a plurality of interlocking members formed along the boundary wall for releasable inter-engagement with the corresponding interlocking members of an adjacent panel so that two or more panels can be interlocked together laterally; and (c) a plurality of grooves configured to form a groove design on the top surface and the bottom surface within the outer body section for connection with suitable support columns extending upwardly from the top surface or downwardly from the bottom surface. The groove design comprising a plurality of full-circular grooves, semi-circular grooves, and quarter-circular grooves cross-linked with one another positioned around corners and middle section of the outer body section such that a complete circular groove can be formed by one full-circular groove of an individual panel, or by two semi-circular grooves of two interlocked panels, or by four quarter-circular grooves of four interlocked panels, thereby providing multiple connection options with the suitable support columns.

In another embodiment, the inner body section is separable from the outer body section so that a panel without the inner body section can be formed. Preferably, the inner body section and the outer body section are releasably attachable to each other by a locking mechanism formed on the inner and outer body sections. Preferably, the inner body section comprising two planar structures.

Preferably, the panel having a plurality of through holes defined by a framework of interconnecting parts extending from the top surface to the bottom surface configured to provide access areas for planting media and/or water. The through holes in the inner body section are larger than the through holes in the outer body section to allow planting media and/or water to pass through more easily.

Preferably, the interlocking members are extending outwardly from the boundary wall and having laterally extending protrusions to form male locking parts and the corresponding female locking parts. Preferably, the panel is made from recycled polypropylene, and the dimensions of the panel are 1 m (length) x 0.5 m (width) x 0.04 m (thickness).

In accordance with embodiments of this invention, a multilayer panel structure to be

positioned underground for promoting tree root growth, managing stormwater runoff, or supporting hardscape/softscape area is provided. The multilayer panel structure comprising: (a) two or more layers of the panels wherein each layer of the panels comprising two or more panels interlocked together laterally by the interlocking members; and (b) a plurality of support columns connecting the two or more layers of the panels vertically wherein each of the support columns comprising a hollow tubular body having two opening ends; wherein each opening end of the support column is connectable to a complete circular groove formed by one full-circular groove of an individual panel, or by two semi-circular grooves of two interlocked panels, or by four quarter-circular grooves of four interlocked panels, thereby allowing to reduce the number of the support columns and cost for forming the multilayer panel structure as one support column can be shared by two interlocked panels or four interlocked panels.

Preferably, each of the support columns further comprising a plurality intersecting parts integral to an inner wall of the hollow tubular body and extending along an axial direction of the hollow tubular body from one opening end to another opening end dividing the hollow tubular body into several compartments to reinforce the strength of the support column. Preferably, the support columns are being filled with mortar to enhance the compressive strength of the multilayer panel structure.

Preferably, the support columns are made from recycled polypropylene. A two-layer multilayer panel structure with the support columns made from recycled polypropylene having a compressive strength of at least 60 tonnes/m².

Preferably, the support columns are made from polyvinyl chloride (PVC). A two-layer multilayer panel structure with the support columns made from polyvinyl chloride (PVC) having a compressive strength of at least 100 tonnes/m².

In accordance with embodiments of this invention, a pallet for storing goods comprising: (a) a layer of two or more interlocked panels; and (b) a plurality of support legs connected to the groove design on the bottom surface of the two or more interlocked panels.

Brief Description of the Drawings

The above and other features and advantages of this invention are described in the following detailed description of preferred embodiments with reference to the below figures:

Fig. 1 shows a top plan view of a panel in accordance with an embodiment of this invention.

Fig. 2 shows a top perspective view of the panel of Fig. 1.

Fig. 3 shows a bottom plan view of the panel of Fig. 1.

Fig. 4 shows a bottom perspective view of the panel of Fig. 1.

Fig. 5 shows a partial enlarge view of the groove design around a corner of the panel.

Fig. 6 shows a partial enlarge view of the groove design around middle section of the panel.

Fig. 7 shows a top plan view of the outer body section of a panel in accordance with an embodiment of this invention.

Fig. 8 shows a top perspective view of the outer body section of Fig. 7.

Fig. 9 shows a perspective view of an inner body section attachable to the outer body section of Fig. 7.

Fig. 10 shows a top plan view of two interlocked panels of Fig. 1.

Fig. 11 shows a top perspective view of two interlocked panels of Fig. 10.

Fig. 12 shows a top plan view of four interlocked panels of Fig. 1.

Fig. 13 shows a top perspective view of four interlocked panels of Fig. 12.

Fig. 14 shows a partial enlarge view of the groove design around the corners of four interlocked panels.

Fig. 15 shows a multilayer panel structure having three layers of the panels connected by a plurality of support columns.

Fig. 16 shows a perspective view of a support column in accordance with an

embodiment of this invention.

Detailed Description of the Invention

A first aspect of this invention relates to an interlockable panel adapted for use to form a multilayer panel structure to be installed underground for promoting healthy tree root growth, managing stormwater runoff, and supporting hardscape/softscape areas. A second aspect of this invention relates a panel adapted for use to form a pallet (e.g. formed by two interlocked panels with support legs) for storing goods and movable from one location to another by a forklift.

Figs. 1 & 2 show a top plan view and a top perspective view of panel 100 in accordance with an embodiment of the invention. Figs. 3 & 4 show a bottom plan view and a bottom perspective view of panel 100. Panel 100 is an environmentally friendly product made from waste materials. Panel 100 is a single piece moulded planar structure made from 100% recycled plastic materials (preferably polypropylene) by an injection moulding machine. Panel 100 is also a sustainable product as at the end of its life cycle, it can be crushed and turned into a useful raw material for making new products, thereby help to reduce waste and carbon footprint. Due to its functional design and material use, panel 100 is lightweight (less than 4 kg), high loading capacity, reusable, strong, sturdy, durable, cost effective, and easy to install/disassemble.

Panel 100 comprising top surface 102 having a perimeter edge, bottom surface 104 having a perimeter edge, and boundary wall 106 extending from the perimeter edge of top surface 102 to the perimeter edge of bottom surface 104, wherein top and bottom surfaces 102, 104 are direct opposing each other. A main body is thus defined by top surface 102, bottom surface 104 and boundary wall 106, where boundary wall 106 having two parallel length sides 106A and two parallel width sides 106B. The main body comprising two sections (non-separable), i.e. outer body section 110 and inner body section 108 enclosed by outer body section 110. Panel 100 may be formed in any suitable shape and size, such as rectangular (length sides 106A > width sides 106B) or square (length sides 106A = width sides 106B). For example, panel 100 as shown in Fig. 1 has a rectangular shape with dimensions of

1000 mm (length) x 500 mm (width) x 40 mm (thickness). Alternatively, panel 100 may be formed in a square shape (not shown) with dimensions of 500 mm (length) x 500 mm (width) x 40 mm (thickness).

In another embodiment of panel 100, inner body section 108 and outer body section 110 are separable from each other (see Figs. 7 to 9). Hence, panel 100 of this particular embodiment may be used with or without inner body section 108 attached to outer body section 110. To produce this panel, two separate moulds are required for making the inner and outer body sections 108, 110 separately. A panel without inner body section 108 (i.e. outer body section 110 as shown in Figs. 7 & 8) may be useful for applications where big openings (through holes) are required, such as tree root protection system, so that planting media and/or tree roots can pass through the panel more easily through the big openings. Furthermore, such panel may reduce the product cost as less material is required for making the panel. Inner body section 108 may comprise of one or more planar structures in any suitable shape and size. For example, inner body section 108 comprised of two octagonal shaped planar structures are shown in Fig. 9. Inner body section 108 is attachable to outer body section 110 by locking members 112 formed along the outer sides 114 of inner body section 108 and the corresponding inner sides 116 of outer body section 110. Locking members 112 adopt a slot-type locking mechanism comprising male locking parts 112A and female locking parts 112B. Hence, inner body section 108 can be releasably attached to outer body section 110. Other suitable types of locking mechanism or locking parts may also be used so long that they allow the inner and outer body sections 108, 110 to be attached firmly and securely, and to be detached conveniently.

Panel 100 has a plurality of interlocking members 118 formed along the outer sides of boundary wall 106 for inter-engagement with the corresponding interlocking members of another panel, thereby allowing two or more panels 100 interlocked together laterally to form a layer of two or more panels 100. For examples, Fig. 10 shows a layer of panels 300 formed by two interlocked panels 100, and Fig. 12 shows a layer of panels 300 formed by four interlocked panels 100. Interlocking members 118 adopt a slot-type locking mechanism having male locking parts 118A and the corresponding female locking parts 118B. Hence, any number of panels 100 can be interlocked together and disengaged by hands (or tool) easily

without damaging the panels. The used panels can also be reusable for a new installation as panel 100 is strong, durable and able to last for many years. Other suitable types of locking mechanism or interlocking members may also be used so long that they allow two or more panels 100 to be laterally connected firmly and securely, and to be disconnected conveniently.

Panel 100 has a plurality of through holes 120 formed in inner body section 108 and outer body section 110 allowing planting media (e.g. soil) and/or water to pass there through. Through holes 120 can be in any shape and size defined by a framework of interconnecting parts 122 extending from top surface 102 to bottom surface 104. Interconnecting parts 122 also act as reinforcing ribs to provide structural strength and rigidity of panel 100. For examples, through holes 120 of square and rectangular shapes can be found in inner body section 108, and through holes 120 of triangular and rectangular shapes can be found in outer body section 110. As can be seen from the figures, through holes 120 in inner body section 108 are larger than through holes 120 in outer body section 110, thereby allowing planting media and/or water to pass through panel 100 more easily. The smaller through holes 120 (i.e. denser configuration) of interconnecting parts 122 of outer body section 110 also enhances the rigidity of panel 100, thereby increasing the loading compacity (compressive strength) of panel 100.

Panel 100 has a plurality of grooves 124 formed on top surface 102 and bottom surface 104 within outer body section 110. Grooves 124 are narrow slots extending inwardly from top surface 102 and bottom surface 104 configured to form a groove design or pattern on top surface 102 and bottom surface 104 for connection with suitable support columns or legs. A multilayer panel structure can be formed by two or more layers of interlocked panels 100 connected vertically by support columns. Top surface 102 and bottom surface 104 have an identical groove design facing in opposite directions separated by a thin base 126 (few millimetres thick) in-between (see Figs. 5 & 6). The depth of the grooves 124 should be sufficient for connecting with the support columns in a tight-fit manner. The groove design comprising a plurality of full-circular grooves 128A, semi-circular grooves 128B, and quarter-circular grooves 128C cross-linked or interconnected with one another and disposed mainly around corners 130 and middle section 132 (near edges of the length sides) of panel 100 as

indicated in Figs. 2 and 4.

Fig. 5 shows a partial enlarged view of the groove design around a corner 130 of panel 100 where a full-circular groove 128A, two semi-circular grooves 128B, and a quarter-circular groove 128C are cross-linked or interconnected with one another. Fig. 6 shows a partial enlarged view of the groove design around middle section 132 of panel 100 where a full-circular groove 128A and a semi-circular groove 128B are cross-linked or interconnected to each other. Due to the unique groove design, a complete circular groove may be formed by a full-circular groove 128A of an individual panel 100 (e.g. circular groove 134 as shown in Figs. 10 & 14), or formed by two semi-circular grooves 128B of two interlocked panels 100 (e.g. circular groove 136 as shown in Figs. 10 & 14), or formed by four quarter-circular grooves 128C of four interlocked panels 100 (e.g. circular groove 138 as shown in Fig. 14). Therefore, depending on the project requirements and budget, user may choose to connect a support column to a circular groove formed by full-circular groove 128A, or to a circular groove formed by two semi-circular grooves 128B, or to a circular groove formed by four quarter-circular grooves 128C. This inventive feature provides multiple connection options with the support columns as one support column can be shared by two interlocked panels 100 or four interlocked panels 100, thereby allowing us to reduce the number of support columns for forming a multilayer panel structure. As a result, the material cost and installation cost of a multilayer panel structure can be reduced significantly, especially for a large multilayer panel structure. For example, with reference to Fig. 10, two interlocked panels 100 may be connected with less than the maximum number of twelve support columns, such as nine support columns where three of them are shared by two panels (i.e. three sets of circular groove 136).

A multilayer panel structure 500 can be formed by two or more layers of panels 100 connected vertically by support columns 400. For example, Fig. 15 shows a multilayer panel structure 500 formed by three layers of panels 300. Depending on the application, a large multilayer panel structure 500 of few hundred or thousand square meters can be constructed. Void space 410 is created between two layers of panels 100 separated by support columns 400. Panels 100 with through holes 120 allow void space 410 to be filled with soil (or other planting media) but prevent the soil from being compacted by vertical loads. This creates a

protected growth zone within void space 410 with uncompacted soil and filled with sufficient oxygen and moisture for promoting healthy tree root growth. So, multilayer panel structure 500 can be used as a tree root protection system by installing the structure around the root ball of a big tree so that the roots may grow and extend freely into the protected growth zone that filled with oxygen and moisture to nurture the tree roots. Furthermore, a protected grown zone with lesser support columns 400 inside the zone can be created due to the unique groove design of panels 100 for sharing of support columns 400. Consequently, tree roots may grow and extend more freely within the protected growth zone with less resistance.

Multilayer panel structure 500 may also be installed under a hardscape/softscape to form a strong and stable underground base for supporting the hardscape/softscape above due to the high compressive strength of multilayer panel structure 500 which can sustain an extreme high vertical load such as fire engine/trunk of 30 tonnes or more. Hence, multilayer panel structure 500 can help to prevent damages to hardscape/softscape due to poor soil structure. Furthermore, multilayer panel structure 500 may also be used to form a water retention or detention system to control and manage stormwater runoff in the urban or flood-prone areas. To form a water retention/detention system, the base and all vertical sides of the system are covered by a layer of waterproofing sheet to retain the stormwater within the system. The system will also be connected with an inlet with filtration to collect stormwater and remove big particles, an outlet to discharge the collected water to public drains in a slower rate, and an overflow outlet to discharge the excess water from the system. Hence, this system provides a cheap and efficient way (made of recycled plastics, no curing time, easy to assemble, less labour time) to manage stormwater runoff to prevent flooding.

Multilayer panel structure 500 can be constructed in any height without restrictions as support columns 400 can be formed in any length as required. Fig. 16 shows a perspective view of support column 400. Support column 400 has a hollow tubular body 402 with two opening ends 404A, 404B. A plurality of intersecting parts 406 are integral to the internal wall of hollow tubular body 402 and extending along an axial direction of hollow tubular body 402 from one opening end 404A to another opening end 404B. Hollow tubular body 402 is therefore divided into several compartments 408 in a circumferential direction by intersecting parts 406 to reinforce the strength and rigidity of support column 400. For

example, a support column 400 with two intersecting parts 406 and four compartments is shown in Fig. 16. If necessary, during installation, support column 400 may be filled with cement grout to further increase the strength of support column 400. Support column 400 may be made from 100% recycled plastic materials (e.g. polypropylene) or polyvinyl chloride (PVC). A two-layer multilayer panel structure 500 with support columns 400 made from polypropylene can achieve a compressive strength of at least 60 tonnes/m². Alternatively, a two-layer multilayer panel structure 500 with support columns 400 made from PVC can achieve a higher compressive strength of at least 100 tonnes/m². Support column 400 has a diameter that allows opening ends 404A, 404B connected to full-circular groove 128A, or a circular groove formed by two semi-circular grooves 128B, or a circular groove formed by four quarter-circular grooves 128C.

While this invention has been described in certain aspects and with reference to specific embodiments. It should be understood by those skilled in the art that various modifications and/or variations may be made to the invention without departing from the scope of the invention as broadly described and as set forth in the following claims. Thus, the embodiments should be considered in all respects as illustrative and not restrictive.

CLAIMS

[Claim 1] A panel comprising:

a top surface, a bottom surface opposing the top surface, a boundary wall extending from a perimeter edge of the top surface to a perimeter edge of the bottom surface defining a main body comprising an outer body section and an inner body section enclosed by the outer body section, wherein the boundary wall having two parallel length sides and two parallel width sides;

a plurality of interlocking members formed along the boundary wall for releasable inter-engagement with the corresponding interlocking members of an adjacent panel so that two or more panels can be interlocked together laterally; and

a plurality of grooves configured to from a groove design on the top surface and the bottom surface within the outer body section for connection with suitable support columns extending upwardly from the top surface or downwardly from the bottom surface, wherein the groove design comprising a plurality of full-circular grooves, semi-circular grooves, and quarter-circular grooves cross-linked with one another positioned around corners and middle section of the outer body section such that a complete circular groove can be formed by one full-circular groove of an individual panel, or by two semi-circular grooves of two interlocked panels, or by four quarter-circular grooves of four interlocked panels, thereby providing multiple connection options with the suitable support columns.

[Claim 2] The panel of claim 1, wherein the inner body section is separable from the outer body section so that a panel without the inner body section can be formed.

[Claim 3] Th panel of claim 2, wherein the inner body section and the outer body section are releasably attachable to each other by a locking mechanism formed on the inner and outer body sections.

[Claim 4] The panel of claim 2, wherein the inner body section comprising two planar structures.

[Claim 5] The panel of claim 1, wherein the panel having a plurality of through holes

defined by a framework of interconnecting parts extending from the top surface to the bottom surface configured to provide access areas for planting media and/or water.

[Claim 6] The panel of claim 5, wherein the through holes in the inner body section are larger than the through holes in the outer body section to allow planting media and/or water to pass through more easily.

[Claim 7] The panel of claim 1, wherein the interlocking members are extending outwardly from the boundary wall and having laterally extending protrusions to form male locking parts and the corresponding female locking parts.

[Claim 8] The panel of claim 1, wherein the panel is made from recycled polypropylene.

[Claim 9] The panel of claim 1, wherein dimensions of the panel are 1 m (length) x 0.5 m (width) x 0.04 m (thickness).

[Claim 10] A multilayer panel structure to be positioned underground for promoting tree root growth, managing stormwater runoff, or supporting hardscape/softscape area, the multilayer panel structure comprising:

two or more layers of the panels of any of claims 1 to 9 wherein each layer of the panels comprising two or more panels interlocked together laterally by the interlocking members; and

a plurality of support columns connecting the two or more layers of the panels vertically wherein each of the support columns comprising a hollow tubular body having two opening ends;

wherein each opening end of the support column is connectable to a complete circular groove formed by one full-circular groove of an individual panel, or by two semi-circular grooves of two interlocked panels, or by four quarter-circular grooves of four interlocked panels, thereby allowing to reduce the number of the support columns and cost for forming the multilayer panel structure as one support column can be shared by two

interlocked panels or four interlocked panels.

[Claim 11] The multilayer panel structure of claim 10, wherein each of the support columns further comprising a plurality intersecting parts integral to an inner wall of the hollow tubular body and extending along an axial direction of the hollow tubular body from one opening end to another opening end dividing the hollow tubular body into several compartments to reinforce the strength of the support column.

[Claim 12] The multilayer panel structure of claim 10, wherein the support columns are being filled with mortar to enhance the compressive strength of the multilayer panel structure.

[Claim 13] The multilayer panel structure of claim 10, wherein the support columns are made from recycled polypropylene.

[Claim 14] The multilayer panel structure of claim 13, wherein a two-layer multilayer panel structure with the support columns made from recycled polypropylene having a compressive strength of at least 60 tonnes/m².

[Claim 15] The multilayer panel structure of claim 10, wherein the support columns are made from polyvinyl chloride (PVC).

[Claim 16] The multilayer panel structure of claim 15, wherein a two-layer multilayer panel structure with the support columns made from polyvinyl chloride (PVC) having a compressive strength of at least 100 tonnes/m².

[Claim 17] A pallet for storing goods comprising:
a layer of two or more interlocked panels of claim 1; and
a plurality of support legs connected to the groove design on the bottom surface of the two or more interlocked panels.