

"Green wall system"

Cross-Reference to Related Applications

The present application claims priority from Australian Provisional Patent Application No 2008903795 filed on 24 July 2008, the content of which is incorporated
5 herein by reference.

Field of the Invention

This invention relates to a module for use in a system for creating vegetated or "green" walls and to a system incorporating such a module.
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Background of the Invention

With increasing development and urbanisation, and growing concern with the effects of climate change, there is an increasing emphasis on the need to "green" buildings and cities to make them more ecologically friendly. Cities in particular tend
15 to be warmer than surrounding rural areas, and city buildings tend to absorb and trap heat, prior to radiating the heat into their surroundings. Rooftop greening is known to mitigate this effect as it tends to insulate the roof of the building and reduces the amount of energy required to heat or cool the building having the green roof.

Advantageously, green roofs may also retard storm water runoff and can
20 enhance the life of a roof by shielding the roof from exposure to ultra violet rays and temperature effects.

However, the roof is only one facet of a building and in certain cases it would be desirable to provide a similar effect for insulation, appearance and/or other environmental reasons, on one or more walls of a building.

25 There are some climbing plants, such as ivy, which will naturally grow on the wall of a building. However, ivy can damage the face of a building and ivy and other climbing plants take a long time to grow to cover a wall. Also the use of climbing plants such as ivy does not provide for variety in appearance of the plants making up the green wall. Ivy is also difficult to control.

30 Attempts have been made to design green walls for buildings, walkways and for garden features. These typically involve attaching sheets of material which may support plant growth to a wall and inserting plants in that material. These have met with varying degrees of success but tend to be expensive, and once installed, it is often difficult to maintain the wall by e.g. removing dead plants and/or adding new plants for
35 variety.

Any discussion of documents, acts, materials, devices, articles or the like which has been included in the present specification is solely for the purpose of providing a context for the present invention. It is not to be taken as an admission that any or all of these matters form part of the prior art base or were common general knowledge in the field relevant to the present invention as it existed before the priority date of each claim of this application.

Summary of the Invention

In a first broad aspect, the present invention provides a module for use in a green wall system comprising a box having a base, sides a front, a rear and a top, at least some of the side, rear and base preferably defining a plurality of relatively smaller apertures, typically of the order of 10 to 30 mm in effective diameter, and wherein the front panel defines a plurality of apertures which are substantially larger in effective diameter than the relatively smaller apertures, typically of the order of 10 to 20 cm.

In one embodiment the box may be made up of panels some of which typically define clips to clip the panel together to form the module together. At least some of the base and side panels may include panels of the type comprising include two substantially parallel planar members each of which defines an ordered array of circular apertures linked by a series of columns extending normally between the two surfaces.

However, in some embodiments where water is provided by irrigation pipes the apertures in the sides, rear, and in some cases even the base may be omitted, as long as water is able to drain out of the larger apertures in the front panel. The smaller holes do however save weight as well as assist with drainage.

The smaller apertures are typically circular, but need not be and could be square or any suitable shape. The larger diameter apertures in the front face are typically generally square.

However, instead of being made up from panels the module may be moulded in two parts, or even one part, with a separate lid.

Where the module is made of panels, the depth of the module as measured from the wall outwards in a generally horizontal direction, may be adjusted by adjusting the width of the side and base panels.

In use, the module may be lined with a permeable geo-textile bag and filled with a planting mix. The bag is slit through the larger apertures in the front panel and plants inserted into the mix. The module may be placed on a rack or shelving but more preferably is fixed to support rails mounted to a wall. In a preferred embodiment the

module is sandwiched between front and rear frames to improve its durability and to hold the panels of the module together.

Thus in a related aspect, the present invention provides a green wall system including support rails for attachment to a wall or the like and a module which is
 5 attachable to the support rails, the module comprising a box for receiving a growing medium, the box typically including a lid, and a front defining apertures for plants, and including engagement means for removably attaching the module to the support rails.

The module may be clamped between a front frame and a rear frame sandwiching the box, with one or more joining members, such as a threaded rod
 10 retaining the frames together and sandwiching the box therebetween.

The frames increase the strength of the box and are particularly advantageous where the module is made from separate panels.

The front and rear frames are preferably U-shaped having a base and sides and formed from metal such as steel. The preferably have an L--shaped cross-section.
 15 Making the frames U-shaped allows the lid of the module to be removed without removing the frame. It also allows the frame to be slid onto the box from one edge without disturbing plants growing through the front of the box which can spread to a wider area than the front of the box when well established.

The support rails typically define one or more vertical arrays of keyhole shaped
 20 apertures. Nuts which attach to the threaded rods define hexagonal nut portions define protrusions, a relatively narrower waist portion and a relatively larger distal head for engagement in the keyhole shaped slots.

In use, the module may be assembled into a box from the panels only (leaving the top panel off) and lined with a geo-textile permeable membrane or bag. Once the
 25 box is assembled and geo-textile liner inserted, growing medium mixed with a light weight product that takes up volume is inserted in the box. The lightweight materials may reduce the ability of the growing medium to hold water, if so, it is preferred that a wetting agent and/or moisture retaining agent is added to counteract that effect. After being filled with growing medium the top of the permeable membrane or bag is folded
 30 over, a top panel is then inserted/attached so that the box is closed and the module is turned through 90° and placed on its rear so that the front face faces upwards. The geo-textile covering the larger apertures in the front panel may then be cut to allow the insertion of plants into the growing medium box through the larger apertures in the front face of the module. Once the plants are grown, if required, the front and rear
 35 frames are placed around the front and rear of the box respectively and are clamped together.

The modules are then mounted onto the support rails.

The invention also encompasses a kit of parts for forming the modules, framed modules and or framed modules and racking system of the present invention.

Throughout this specification the word "comprise", or variations such as
 5 "comprises" or "comprising", will be understood to imply the inclusion of a stated element, integer or step, or group of elements, integers or steps, but not the exclusion of any other element, integer or step, or group of elements, integers or steps.

Detailed Description of the Drawings

10 Specific embodiments of the present invention will now be described, by way of example only, and with reference to the accompanying drawings in which:

Figure 1 illustrates a first embodiment of a module for use in forming a green wall shown partly exploded with the top of the module shown separately;

Figure 2 shows the module of Figure 1 with the lid attached;

15 Figure 3 shows the module of Figure 1 with a geo-textile lining layer and growing medium located therein;

Figure 4 shows a variant of the embodiment shown in Figure 2, having side walls with relatively larger apertures than the side walls of the module of Figure 2;

Figure 5 shows a variant of the embodiment shown in Figure 2, having a rear
 20 wall with relatively larger apertures than the rear wall of the module of Figure 2;

Figure 6 is a front perspective view of the module of Figure 2 including a reinforcing frame;

Figure 7 is a rear perspective view of the module of Figure 6;

Figure 8 shows a first embodiment of a support rail for mounting modules to a
 25 wall;

Figure 9 shows a second embodiment of a support rail for mounting modules to a wall;

Figure 10 is an enlarged view of the rear of a module showing an anchor nut in more detail;

30 Figure 11 shows a module mounted to a wall on a pair of support rails;

Figure 12 is a rear view of the module shown in Figure 11;

Figure 13 shows a variant of the arrangement shown in Figure 11 including a reinforcing bar for the module;

Figure 14 shows a number of support rails attached to a wall for forming a green
 35 wall;

Figure 15 shows a number of modules (shown empty for clarity) attached to the wall via the support rails; and

Figure 16 is a side view of a green wall showing plants growing from the modules.

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Detailed Description of the Preferred Embodiments

Referring to the drawings, Figures 1 and 2 illustrate a module 10 for growing plants for use in a green wall system embodying the present invention. The module 10 is in the form of an open topped box having five faces a base 12, rear wall 14, side walls 16 and 18 and a front wall 20. The box has a separate, removable lid 22.

In one embodiment, the faces of the box comprise separate panels in the form of high strength lightweight structural panels, typically made of injection moulded recycled plastics which incorporate snap-on clips for ease of assembling the module. The side top and base panels may be formed from drainage cells and including two substantially parallel planar members each of which defines an ordered array of circular apertures linked by a series of columns extending normally between the two surfaces. One array of apertures is offset from the other. The apertures which allow the drainage of water therethrough are in the order of a few centimetres in diameter. Suitable panels are described in the applicant's earlier International patent application No PCT/AU01/00001, the entire contents of which are incorporated herein by reference. The rear panel defines a single array of apertures but incorporates reinforcing struts. The edge of the rear panel may defines protrusions (not shown) for engagement in apertures of the side, base and rear panels. However, the exact structure of the panels and how they inter-engage is not critical and may be varied.

Indeed, instead of being formed from panels, the box may be moulded in one piece with a separate lid or in two pieces. How the box is formed and the material used to form the box is not critical.

The front face 20 is generally rectangular having a width of about 500mm and a height of about 560mm. It will be appreciated that the dimensions of the front face and the other dimensions of the module may be varied. It defines an outer frame 23 from which extends a grid of orthogonally intersecting members 24a, b, c and 26a, b, c defining a total of sixteen generally square apertures 27. The width of each aperture is typically about 10 - 12 centimetres. It will be appreciated that the shape and size of the apertures may be varied from that shown.

With reference to Figures 1 and 2, it can be seen that the circular apertures 28 in the rear, base and side faces are much smaller than the apertures 27 of the front face.

Typically they will be an order of magnitude smaller than the apertures 27 in the front face, and from about 10 to 30mm in effective diameter. Again, the shape of the apertures may be varied from the circular shapes shown in the Figures.

Figure 2 shows the box after it has been "closed" by the lid 30 which defines apertures 28 of a similar size to those of the rear and side faces. Also shown in Figure 2 are a series of four smaller apertures 32 in the front face of the box close to the side edges of the front face. These apertures receive threaded bolts for holding the box together and attaching the box to rails, as is described in more detail below.

With reference to Figure 3, once the front, rear, sides and base of the box 10 have been assembled together to form an open topped box, a water permeable liner in the form of a permeable geo-textile liner 40 typically in the form of a bag, is placed in the box covering the sides, front, rear and base. A suitable planting mixture 42 is then inserted in the module. The planting mixture 42 should ideally be as lightweight as possible, as the module has to hang from a wall or the like, and typically comprises a growing medium into which is mixed a filler that takes up volume but which weighs very little. Because the filler will typically reduce the ability of the growing medium to hold water, it is preferred that a wetting agent or water retaining agent is included in the mix to counteract that effect.

Once the module 10 has been filled with planting mixture, the top of the geo-textile bag is folded over to cover the planting mix and the top 22 of the module is attached. The module is then turned onto its rear face 14 so that the front panel 20 faces upwards. The geo-textile covering the square apertures 27 is slit to allow the insertion of plants into the planting mixture through the sixteen apertures 27. It will be appreciated that any mix of suitable plants may be placed in the module. The plants may be allowed to grow for a period in the module, with the module resting on its rear wall 14, and once the plants are sufficiently established, the modules can then be transported to the site of the green wall.

Figures 4 and 5 show variations of the module shown in Figures 1 to 3. In the module 10a of Figure 4 both sides 16 and 18 have large diameter apertures 50 similar in size to those 27 of the front face 12. This variation can be used in applications where it is desirable for plants to grow out from the sides of the module also, e.g. where the module is located at the edge of an array of modules forming a green wall. In Figure 5, the rear wall 14 of the module 10b has larger apertures 52, similar to those of the front wall, whereas the apertures in the side walls 16, 18 are relatively smaller. This module can be used in applications where the front and rear of the green wall are visible, e.g.

when the modules are used to create a dividing wall. Larger apertures in the rear and/or sides can also be used to reduce the weight of the module.

With reference to Figures 6 and 7, prior to mounting them on a wall, the assembled modules 10 are clamped between identical front 100 and rear 102 steel frames. Each frame is U-shaped in plan view and comprises a base 104 and two side members 106, 108, each having an L-shaped cross section. As shown, the frames enclose/cover the side edges and base edges of the front and rear faces of the module respectively. The front and rear frames are clamped together by a series of four threaded steel fastening bolts 110 which extend through the module, through the holes 32, and between the front and rear 102 steel frames. Thus the module is sandwiched between the front 100 and rear frames 102. It will be appreciated that the depth of the module 10 measured from the front to the rear, may be adjusted by adjusting the width of the side panels, base and top, and the length of the fastening bolts 110. Thus the system embodying the present invention may easily provide walls of different depths, depending on the particular application, and requirements of the installation.

The U-shaped frames have the advantage that the lid 22 of the module may be removed without first removing the frame.

The ends of the bolts locate in custom designed anchor nuts 114 which define anchor means for fixing the module to a rail. With reference to Figure 10, each anchor nut 114 has a first hexagonal nut portion 116 a reduced diameter waist portion 118 and a larger diameter rounded head 120.

Figures 8 and 9 show support rails 150, 152 or pilasters for mounting the modules to a wall or the like. The support rails define a series of key-hole shaped apertures 154 for receiving the anchor nuts 114. The apertures have a larger diameter portion 155a which is slightly larger than the head 120 of the anchor nut and a lower, narrower portion 155b which is narrower than the head but wider than the waist portion 118. Figure 8 shows a single rail 150 having one set of apertures and Figure 9 a double rail 152 defining two sets of parallel apertures. The rails 150, 152 also define holes 156 for mounting the rails to a wall using screws or the like. Although the support rails are shown in a vertical orientation, it will be appreciated that they may extend horizontally instead, although the keyholes would still need to be oriented vertically.

In use, as illustrated in Figures 11 and 12, the rails are 150, 152, are mounted to a wall or the like where a green wall is to be created, spaced apart by the width of a module. The heads 120 of the anchor nuts of a module are located in the larger diameter portion of the keyhole shaped slots 154 and the module is lowered so that the

waist portion 118 is located in the narrower part 155b of the keyhole, thus securing the module in place. Figures 11 and 12 shows a module secured to support rails 150, 152.

When mounted on the rails it will be appreciated that the modules are maintained at a fixed distance from the wall. This is useful as it allows for ventilation
 5 and the installation of services, and also prevents contact of the module with the wall.

It will be appreciated that other means for attachment of the modules to rails may be provided and that the modules may be fixed directly to a wall although the use of the rails has significant advantages over direct fixing of the modules.

Figure 13 illustrates a variant of the invention in which a steel support bar 160 is
 10 attached between the sides of the front frame 100 for reinforcing the module and preventing bowing of the front face of the module due to the weight of material and water contained in the module.

Figures 14 and 15 illustrate a larger scale green wall, with Figure 14 showing a number of rails 150, 152, fixed to a wall. Figure 15 illustrates nine modules 10 fixed to
 15 the wall. The modules are shown without the liners, growing medium and plants which would be present in an actual installation. The modules are spaced apart by gaps of 5 to 10cm or so from the modules above and below them. That gap makes it possible to remove and replace individual modules, from the green wall installation, if desired for changing the plant make up of the wall, removing dead plants or the like. The gaps
 20 also allow installation of irrigation pipes between modules where necessary.

Figure 16 is a side view of the installation including plants 200. With the system of the present invention where the plants are first established in modules in a nursery or the like and then transported to site, it will be appreciated that a wide variety of plants may be used in the green wall.

25 The system of the present invention is flexible in that the depth of the modules may be adjusted to suit the application and/or load bearing ability of the wall. Depending on the depth of the module, planting depths of about 80 -210 mm may be achieved to accommodate various climatic and plant species requirements.

The modules may be used without the frames, and simply placed on shelving
 30 rather than attached to the support rails. In a further variant, the frames may be omitted and the modules may be fixed to a wall without the support rails. In this embodiment the anchor bolts and anchor nuts may still be used with the bolts extending from the front to the rear of the module. Alternatively, the anchor means (118 120) may be moulded directly into the rear of the module.

In a further variant, the rails may define different slot shapes for receiving anchor means other than keyhole slots and the module may define corresponding engagement means for removable engagement in the rails.

5 It is also possible to attach sheets of mesh or infill panels to the rails using the anchor nuts, if desired, instead of one or more modules.

The green wall system of the present invention can thus be used to improve the aesthetics of a building or site and the sound and heat insulation of walls and facades and the like. Plants growing in the modules may provide enhanced air quality and will tend to reduce air borne pollutants and storm water runoff. Water will drain down
10 through the modules from top to bottom. Being a modular system it will be appreciated that the plants in the green wall may be easily changed by removal and replacement of modules.

The wall system may be applied to building facades, screen walls, walkways, linkways, feature walls or the like or may be used in garden landscapes. The modules
15 and system may also be used on sloping roofs or flat roofs and e.g. tied together.

It will be appreciated by persons skilled in the art that numerous variations and/or modifications may be made to the invention as shown in the specific embodiments without departing from the scope of the invention as broadly described. The present embodiments are, therefore, to be considered in all respects as illustrative
20 and not restrictive.

CLAIMS:

1. A module for use in a green wall system in the form of a box having a base, sides, a front, a rear and a top, at least one of the sides, rear and base defining a plurality of first apertures of a first size, and wherein the front defines a plurality of apertures which are substantially larger in effective diameter than the first apertures.
2. A module as claimed in claim 1 wherein the larger apertures are an order of magnitude larger than the first apertures.
3. A module as claimed in claim 1 or 2 wherein the first apertures have a diameter of between 10 and 30mm and the larger apertures are substantially rectangular and are from 10 to 20 cm wide.
4. A module as claimed in any one of claims 1 to 3 wherein the rear and base define apertures of the first size, and the front and one or both side walls define the larger apertures.
5. A module as claimed in claim 2 or claim 4 wherein the larger apertures are from 10 to 15cm wide.
6. A module as claimed in any one of claims 1 to 5 wherein, the module is in the form of a rectangular parallelepiped formed from an assembly of lightweight structural moulded panels made from a plastics material.
7. A module as claimed in any one of claims 1 to 6 wherein the module is formed from recycled HPDE or polypropylene.
8. A module as claimed in any preceding claim including a water permeable liner, lining the box, growing medium contained in the liner and plants rooted in the growing medium and growing through the apertures.

9. A green wall system including support rails for attachment to a wall or the like and a module which is removably attachable to the support rails, the module comprising a box for receiving a growing medium, the box having a base, sides, a front, a rear and a top, at least one of the sides, rear and base defining a plurality of first
5 apertures of a first size, and wherein the front defines a plurality of apertures which are substantially larger in effective diameter than the relatively smaller first apertures.
10. A green wall system as claimed in claim 9 wherein the module is a module according to any one of claims 1 to 8.
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11. A green wall system as claimed in claim 9 or 10 including a front frame and a rear frame sandwiching the box, with one or more joining members, retaining the frames together and sandwiching the box therebetween, and wherein the front and rear frames have an L--shaped cross-section.
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12. A green wall system as claimed in any one of claims 9 to 11 wherein the support rails define one or more vertical arrays of keyhole shaped apertures and the rear frames define protrusions having a larger head and a waist portion, which is narrower than the larger head, for engagement with the apertures.
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13. A green wall system as claimed in claim 12 wherein the joining members are threaded bolts and anchor nuts and the distal end of the anchor nuts define the protrusions having the larger head and narrower waist portion for engagement with the keyhole shaped apertures.
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14. A green wall system as claimed in any one of claims 9 to 13 wherein at least one of the side, rear and base defining a plurality of first apertures of a first size, and wherein the front defines a plurality of apertures which are substantially larger in effective diameter than the first apertures.
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15. A method of forming a green wall system comprising the steps of:-
a) providing a module as claimed in any one of claims 1 to 7;
b) inserting a geo-textile liner into the box, placing growing medium in the liner and closing the top of the box with the lid;
35 c) placing the module on its rear so that its front faces upwards and cutting or removing part of the geo-textile covering the larger apertures in the front panel;

- d) inserting of plants into the growing medium box through the larger apertures in the front face of the module and allowing the plants to become established;
- e) providing support rails on a wall defining first engagement means for engaging with corresponding engagement means defined on the rear of the module; and
- 5 f) removably mounting the module onto support rails fixed to a wall using the engagement means.

16. A method as claimed in claim 15 wherein the support rails define one or more vertical arrays of keyhole shaped apertures defining the first engagement means and the
10 rear of the module defines protrusions having a larger head and a waist portion, which is narrower than the larger head, for engagement with the apertures defining the corresponding engagement means .

17. A green wall system as claimed in claim 14 including threaded bolts passing
15 from the front to the rear of the module and anchor nuts wherein the distal end of the anchor nuts define the protrusions having a larger head and a narrower waist portion for engagement with the keyhole shaped apertures.