A panel system connector may be used to connect a system of panels to be used as a structure, such as a temporary roadbed, for example. The panel system connector may include a latch movable between a locked position and an unlocked position. The latch may be biased to the locked position. The connector may include multiple portions with a first portion including the latch and a second portion including a receiver configured to receive the latch in the locked position to secure multiple panels together.
PANEL SYSTEM CONNECTOR

FIELD OF THE INVENTION

[0001] The present disclosure relates generally to high strength-to-weight support platforms and temporary roadbeds. More specifically, it relates to platforms and temporary road beds on which motor vehicles can travel.

BACKGROUND OF THE INVENTION

[0002] In some instances, a construction site is located in a remote site with no established road leading to the site. Remote construction may require access of large equipment, but not require long-term access by road. When a permanent road is not required, a temporary road that is capable of supporting the traffic necessary to comprise construction may be utilized. Remote construction sites may be utilized for the erection of remote utility structures, such as towers for support of electrical lines, radio equipment, or cellular telephone equipment.

SUMMARY OF THE INVENTION

[0003] The present disclosure comprises one or more of the features recited in the appended claims and the following features which, alone or in any combination, may comprise patentable subject matter.

[0004] A panel apparatus used as a structure, such as a roadbed, for example, comprises a first panel and a second panel. The first panel may include a locking assembly secured to the first panel, the locking assembly including a latch movable between a locked position and an unlocked position. The second panel may include a bracket having a through-hole positioned to receive the latch of the locking assembly therethrough when the latch is in the locked position. The latch is received within the bracket, the first and second panels may be secured to one another. The panel apparatus may further comprise a retainer positioned such that the latch may be displaced to engage with the retainer to maintain the latch in the unlocked position. The latch may translate in a first generally horizontal axis between the locked position and the unlocked position. Further, the latch may translate in a second generally horizontal axis between a position engaging the retainer and a position disengaged from the retainer. The latch may be biased to the locked position by an elastomer. In some embodiments, the elastomer may be omitted and replaced with another bias member such as a compression spring. The first panel may further comprise a guide which supports the latch when the latch moves between the first locked position and the unlocked position.

[0005] In another embodiment, the panel apparatus may comprise a panel and a locking mechanism secured to a perimeter of the panel and extending laterally outwardly from the panel in a lateral direction therefrom. The locking mechanism may include a latch having an oblique surface transverse the longitudinal length of the latch. The oblique surface may extend substantially across a thickness of the latch and the latch may be movable along the longitudinal length of the latch between the first and second positions. The latch may be biased to the first position.

[0006] In some embodiments, the locking mechanism may further comprise a guide to support the latch. The locking mechanism may further comprise a bias member positioned between the latch and the guide. The locking mechanism may further comprise a retainer configured to engage with the latch to maintain the latch in the unlocked position.

[0007] In another illustrative embodiment, a panel connector assembly may comprise a first portion configured to be secured to the perimeter of a first panel and a second portion configured to be secured to a perimeter of a second panel. The first portion may have a latch movable between a locked position and an unlocked position. The second portion may have a receiver configured to receive the latch of the first portion when the latch is in the locked position to thereby secure the first and second portions together. In some embodiments, the latch of the first portion may be biased to a locked position. In other embodiments, the latch may include a longitudinal length and have a surface transverse the longitudinal length the surface being oblique to the longitudinal length. In some embodiments the oblique surface may be engaged by a portion of the receiver when the first portion is engaged with the second portion. When the first portion engages with the second portion the oblique surface may act as a cam to displace the latch longitudinally until the latch is positioned to be received by the receiver to secure the first and second portions to one another.

[0008] Additional features, which alone or in combination with any other feature(s), including those listed above and those listed in the claims, may comprise patentable subject matter and will become apparent to those skilled in the art upon consideration of the following detailed description of illustrative embodiments exemplifying the best mode of carrying out the invention as presently perceived.

BRIEF DESCRIPTION OF THE DRAWINGS

[0009] The detailed description particularly refers to the accompanying figures in which:

[0010] FIG. 1 is a perspective view of a system of interlocking panels;

[0011] FIG. 2 is an enlarged perspective view of a portion of the system of interlocking panels of FIG. 1;

[0012] FIG. 3 is an end view of a lap joint connector secured to a panel with a portion of the panel cut away;

[0013] FIG. 4 is an end view of a two panels engaged through lap joint connectors illustrative of the current invention, the connectors secured by a fastener;

[0014] FIG. 5 is an end view of the panels of FIG. 4, the panels deflected by a load;

[0015] FIG. 6 is an end view of two panels engaged through another embodiment of lap joint connectors, the connectors secured by another embodiment of a fastener;

[0016] FIG. 7 is an end view of the panels of FIG. 4, the lap joint connectors including a cavity with reinforcing member received within the cavity;

[0017] FIG. 8 is an end view of the panels, lap joint connectors and fastener of FIG. 6, the connectors including a reinforcing member;

[0018] FIG. 9 is an end view of a set of panels engaged through yet another embodiment of lap joint connector and fastener, the connectors including another embodiment of a reinforcing member;
FIG. 10 is an end view of a lap joint connector secured to a panel with a portion of the panel cut away, the connector having a cavity for a reinforcing member;

FIG. 11 is an end view of two panels engaged through the embodiment of lap joint connectors of FIG. 10, the connectors including a reinforcing member and secured by a fastener;

FIG. 12 is an end view of a lap joint connector secured to a panel with a portion of the panel fragmented, the connector having another embodiment of a cavity for a reinforcing member;

FIG. 13 is an end view of two panels engaged through the embodiment of lap joint connectors of FIG. 12, the connectors including a reinforcing member and secured by a fastener;

FIG. 14 is an end view of another embodiment of lap joint connectors engaged to secure two panels, the connectors including overlapping panel-engaging portions secured to the panels through fasteners;

FIG. 15 is an end view of yet another embodiment of lap joint connectors engaged to secure two panels, the connectors secured to the panels with adhesive and including a fiber reinforcement and the connectors secured by a fastener;

FIG. 16 is a perspective view of another embodiment of a panel with portions cut-away, the panel including a rod and angle connector system to secure adjacent panels to one another;

FIG. 17 is a perspective view of the panel of FIG. 16 with a second panel secured to the first panel through a rod and angle connection;

FIG. 18 is a top view with portions cut away of four of the panels of the embodiment of FIG. 16 secured together at a corner showing the engagement of the rod and angle connectors to secure the four panels to one another;

FIG. 19 is a top perspective view with portions cut away of the corner of FIG. 18;

FIG. 20 is a bottom perspective view with portions cut away of the corner of FIG. 18;

FIG. 21 is a perspective view with portions cut away of another embodiment of panel including a system of hook and loop fasteners to secure adjacent panels to one another;

FIG. 22 is a perspective view with portions cut away of the panel embodiment of FIG. 21 with a second panel secured adjacent the first panel;

FIG. 23 is a top view with portions cut away of four panels of the embodiment of FIG. 21 secured adjacent one another to form a system of panels;

FIG. 24 is a perspective view with portions cut away of the panels of FIG. 23;

FIG. 25A is a perspective view with portions cut away of a corner of still yet another embodiment of a panel including a connector having a biased latch key locking system to secure adjacent panels to one another the latch key in a locked position;

FIG. 25B is the view of FIG. 26A with the latch key in an unlocked position;

FIG. 25C is a cross-sectional view of the connector of FIG. 26A showing the bias member of the connector biasing the latch key to the locked position;

FIG. 25D is a cross-sectional view of the connector of FIG. 26A showing the bias member compressed when the latch key is in the unlocked position;

FIG. 26 is a perspective view of two panels including the connector embodiment of FIGS. 25A-25D positioned adjacent one another and secured together by the latch key of the first panel;

FIG. 27 is a top view with portions cut away of four panels including the latch key connector of FIGS. 25A-25D, the four panels secured together at a corner to form a panel system;

FIG. 28 is a perspective view with portions cut away of the four panels of FIG. 27.

DETAILED DESCRIPTION OF THE INVENTION

The present disclosure includes a system of panels that may be interconnected to form a planar structure, such as a temporary roadbed, for example. Interconnected panels may also be used to construct other structures, such as the walls of buildings, for example. The present disclosure illustrates embodiments of the invention that transfer forces applied normal to a surface of a panel to adjacent panels such that the adjacent panels assist in distributing the forces applied normal to a single panel.

In the illustrative embodiment of FIG. 1, a system of panels 20 includes multiple structures 22. A first structure 22, hereinafter designated as structure 24, is interconnected with a second structure 22, hereinafter designated as structure 26. A third structure 22, hereinafter designated as structure 28, is positioned to be interconnected with both structure 24 and structure 28. Each of the structures 22 includes a panel 30 having a rectangular shape. In other embodiments, the structure 22 may have any of a number of polygonal shapes such as triangular, pentagonal, polygonal, or octagonal, for example. Each of the structures 22 further include a connector portion 32 secured to the panel 30 about the perimeter of the panel 30. The connector portion 32 is secured to the panel 30 by an adhesive in the illustrative embodiment of FIG. 1. In other embodiments, the connector portion 32 may be secured to the panel 30 through any of a number of the fasteners or securing methods. For example, in some embodiments the connector portion 32 may be secured to the panel 30 through fasteners such as screws, nails, bolts, or the like. The connector portion 32 may also be secured to the panel 30 through other securing means such as welding, heat staking, or any of a number of other securing/adhering methods. In still other embodiments, the connector portion 32 and panel 30 may be formed as a single unit through any of a number of molding and forming methods. For example, in some embodiments, the interconnecting elements of the connector portion 32, discussed in more detail below, may be formed in an injection molding process or may be machined from a unitary piece of material to form a structure 22.
Referring now to FIG. 2, the connector portion 32 comprises a series of protrusions 36 positioned about the perimeter of connector portion 32. The protrusions 36 are separated by several cavities 34 formed between the protrusions 36 and configured to receive the protrusions 36 of an adjacent structure 22 such that the protrusions 36 mate with the cavities 34 to form a continuous interface between two structures 22.

Additionally, the protrusions 36 are formed in two alternating profiles about the perimeter of the connector portion 32. An upper profile 38 includes a first series of equally spaced protrusions 36 and a lower profile 40 includes a second series of equally spaced protrusions 36 with the center of each protrusion 36 of a lower profile 40 centered on the center of the cavities 34 of the upper profile 38. This creates an alternating lap joint which facilitates a first structure 22 to support a portion of a load applied to an adjacent structure 22.

The offset of upper profile 38 and lower profile 40 results in the formation of an upper surface 52 on the lower profile 40 protrusions 36 engaging a lower surface 54 on the upper profile 38 protrusions 36. Thus, engagement of a first structure 22 to a second structure 22 results in engagement of the upper surfaces 52 and lower surfaces 54. When the surfaces 52 and 54 are engaged, forces applied normal to a first structure 22 are supported by a second structure 22. This permits distribution of the normal force from the loaded structure 22 to adjacent panels.

Each protrusion 36 includes a through-hole 42 formed in the center of the protrusion 36. The through-holes 42 of the protrusions 36 in the upper profile 38 are positioned to be coaxial with the through-holes 42 formed in the protrusions 36 of the lower profile 40. When a first structure 22 is engaged with a second structure 22, through-holes 42 receive fasteners (not shown), such as pins, that secure the first and second structures 22 and provide for the transfer of forces between the first and second structures 22. Referring again to FIG. 1, the structure 26 engages with structure 24 such that the alternating protrusions 36 engage the cavities 34 to form a unitary structure.

Referring now to FIG. 2, it can be seen that four repeating surfaces 44, 46, 48 and 50, form the protrusions 36 and cavities 34. As can be seen at the corner 58 of the structure 28, the surface 46 of one protrusion 36 and the surface 48 of another protrusion 36 is truncated to provide relief for the corner 58 of the structure 28 to be received at the intersection of the panels 24 and 26. This truncation is necessary at each corner of each structure 22 to permit multiple structures 22 to be engaged at a meeting point of three of the structures 22.

In other embodiments, the alternating lap joint structure of the illustrative embodiments of FIGS. 1 and 2 is replaced by a single lap joint connector having a structure which transfers forces applied to a first panel 30 across adjacent panels 30. Referring now to FIG. 3, a cross-sectional view of another embodiment of a connector 70 is shown engaged with a panel 30 and extending in a lateral direction as shown by an arrow 18. In this illustrative embodiment, the connector 70 is a lap joint connector which comprises a lap joint portion 74 and a panel-engaging portion 72. The lap joint portion 74 includes a lap surface 76. The panel 30 includes a first surface 78 and an opposite second surface 80. When the connector 70 is engaged with the panel 30, the lap surface 76 is oblique to the second surface 80. The connector 70 has a uniform cross-section, as shown in FIG. 3, which extends along a longitudinal length of the connector 70.

In the illustrative embodiment of FIG. 3, the panel engaging portion 72 of the connector 70 includes a panel receiving cavity 82 which includes an upper surface 86, a lower surface 84, and a blind surface 88. The blind surface 88 intersects the upper surface 86 and lower surface 84 to form the terminal surface of the panel-receiving cavity 82. In the illustrative embodiment of FIG. 3, the upper surface 86 and lower surface 84 are parallel and blind surface 88 is perpendicular to the surfaces 84, 86. However, it should be understood that any of a number of geometric relationships might exist between the surfaces of panel receiving cavity 82.

When the panel 30 is received in the connector 70, the surface 86 of the connector 70 engages the surface 78 of the panel 30. Likewise, the surface 84 of the connector engages the surface 80 of the panel 30. The panel-receiving cavity 82 is sized to have the surfaces 86 and 88 simultaneously engage the surfaces 80 and 78 when the panel 30 and connector 70 are engaged. The connector 70 may be engaged with the lap surface 76 in either an upwardly facing orientation or a downwardly facing orientation. For the lap surfaces 76 of adjacent connectors 70 to engage, a first lap surface 76 must be oriented opposite that of a second lap surface 76. The connector 70 is symmetrical so that in either configuration, the connector 70 mates with an adjacent connector 70 while maintaining the adjacent panels 30 in substantially the same plane.

In the illustrative embodiment of FIG. 3, the connector 70 is secured to the panel 30 through an adhesive (not shown) securing the surfaces 84 and 86 to the surfaces 80 and 78 respectively. It should be understood that the connector 70 may be secured to the panel 30 through any of a number of fasteners or adhering methods. In other embodiments, the connector 70 may be secured to the panel 30 through any of a number of the fasteners or securing methods described in more detail below.

Since the lap surface 76 is oblique to the second surface 80, forces applied normally to the first surface 78 of the panel 30 are transferred to the surface 80 and lap surface 76. For example, if the panel 30 is supported by the surface 80 resting on a support surface such as the ground, for example, the force applied normally to the first surface 78 is transferred through the panel 30 and supported by the surface 80. When the lap surface 76 of a first panel/connector combination is engaged with the lap surface 76 of a second panel/connector combination, the force applied to surface 78 of a first panel 30 is transferred through the lap surface 76 of the first combination to the lap surface of the second combination such that the surface 80 of a second panel 30 assists in supporting the load applied to the first panel 30.

In another embodiment of a connector 170, shown in FIGS. 4 and 5, a fastener 96 is added to the connector 170 to provide a structure for securing two adjacent panel/connector combinations to transfer forces between the panels 30. The connector 170 includes a through-hole 94 which is configured to receive fastener 96 therethrough. As shown
in FIG. 4, a first connector 170 is positioned so that the lap surface 76 is in an upwardly facing orientation and engages the lap surface 76, oriented downwardly, of a second connector 170. Each connector 170 includes a through-hole 94, and when the connectors 170 are engaged the through holes 94 are positioned substantially coaxially so that the fastener 96 is received through both of the through-holes 94 to secure the first connector 170 to the second connector 170. The fastener 96 includes a head 98 on each end of the fastener to retain the fastener 96 in engagement with the connectors 170.

[0054] In the illustrative embodiment of FIG. 4, the connectors 170 and fastener 96 are shown in cross-section. It should be understood that through-hole 94 is also shown in cross-section. Multiple through-holes 94 may be positioned along the longitudinal length of connector 170 so that multiple the fasteners 96 may be used in connectors 170 and spaced along the longitudinal length of the connector 170. The fastener 96 of the illustrative embodiment of FIGS. 4 and 5 comprises a hardened metal which supports shear force transferred to the fastener when either of the panels 30 is loaded in support of a force normal to surface 78 or surface 80. In some embodiments, the fastener 96 may comprise other materials such as nonmetallic composite materials. Any material that has the strength to withstand the shear force incurred when panels 30 are loaded may be used in place of the fastener 96.

[0055] Referring now to FIG. 5, the illustrative embodiment of FIG. 4 is shown with a load being transferred through the connectors 170. FIG. 5 is an exaggerated view of the deformaion that occurs when the loads are transferred through the connectors 170 and fastener 96. As can be seen in FIG. 5, the fastener 96 retains the connectors 170 in engagement under loading conditions so that at least a portion of the load is transferred from the connector 170 and panel 30 combination on the right through the lap surface 76 to the lap surface 76 of the connector 170 and panel 30 combination on the left. It should be understood that some of the force transferred is transferred through the fastener 96 which experiences some shear loading as the lap surfaces 76 tend to slide apart in the direction of arrow 100. The oblique orientation of lap surface 76 and the presence of the fastener 96 assists in transferring forces which are loaded normal to surface 78 of panel 30 and from a direction which is directly perpendicular to surface 78 and through the connectors 70 as a shear force to be supported by the adjacent panel 30.

[0056] The design of the connectors 70 and 170 provide the lap surface 76 as an open surface with no recesses. The absence of a requirement for engagement a first connector 70, 170 to engage a second connector 70, 170 through a recess in the connector 70, 170 eliminates the need to clean the recess during installation. In field-use conditions, panels may be assembled in wet and muddy conditions. Lap surface 76 may be cleaned of any mud or debris that may impede the engagement of two lap surfaces 76 during assembly of panels by sliding a cleaning instrument along the lap surface 76.

[0057] In further discussion, other embodiments of the panel and connector system will be discussed. Common features are retained and the same reference designators are used where common with the illustrative embodiment of FIGS. 3-5. For example, in the illustrative embodiment of FIG. 6 a connector 171 is configured to be received within a panel 130. Specifically, the panel 130 includes a first outer plate 102 and a second outer plate 104. A panel engaging portion 172 of connector 171 is received between the outer plates 102 and 104. The connector 171 also includes a lap joint portion 174 with a lap surface 76 functioning in the same manner as the lap surface 76 of the connector 70. The connector 171 is configured so that an upper surface 106 and a lower surface 108 are substantially coplanar with the surfaces 78 and 80 respectively of panel 130 when the connector 171 is secured to panel 130. As shown in FIG. 6, the panel 130 and connector 171 combination on the left is oriented so that the lap surface 76 is in a generally upwardly facing orientation. The panel 130 and connector 171 combination on the right is oriented so that the lap surface 76 is in a generally downwardly facing orientation allowing lap surfaces 76 to be engaged when the panel 130 and connector 171 combinations are positioned side-by-side. Each of the connectors 171 includes a through-hole 194. In the illustrative embodiment of FIG. 6, the through-hole 194 is along an axis that is normal to the lap surface 76. When the two panels 130 are placed in the side-by-side configuration, the through-holes 194 of each of the connectors 171 are positioned in a substantially coaxial configuration so that a fastener 196 may be inserted through the connectors 171 to engage the first panel 130 and connector combination 170 to the second panel 130 and connector 171 combination. The fastener 196 is retained in place by a head 198 on either end of the fastener 196.

[0058] The orientation of fastener 196 allows the fastener 196 to resist separation of the connectors 171 when a panel 130 is loaded. The fastener 196 is loaded in shear when the connectors 171 are urged apart in the direction of arrow 200. In addition, the heads 198 tend to retain the connectors 171 together such that lap surfaces 76 stay in engagement.

[0059] In yet another embodiment, a connector 270 is shown in FIG. 10. Connector 270 is similar to the embodiment of FIGS. 3-5, but includes an additional cavity 110 formed in the lap joint portion 74 of connector 270. The cavity 110 extends along the longitudinal length of connector 270 and is configured to receive a reinforcing member 112 as shown in FIG. 11. In the illustrative embodiment of FIGS. 10-11, the cavity is angularly shaped with a first portion 114 parallel to lap surface 76. A second portion 116 of the cavity 110 is parallel to the surface 78 of the panel 30 and is positioned so that an upper portion 118 of the reinforcing member 112 is substantially coplanar with the surface 78 of the panel 30. The reinforcing member 112 includes portion 118 which is received within the portion 116 of the cavity 110 and a portion 122 which is received in the portion 114 of the cavity 110. As shown in FIG. 11, the through-hole 294 passes through the connector 270 including the retaining member 112. The reinforcing member 112 assists in the distribution of loads transferred by the fastener 96. The reinforcing member 112 is inelastic as compared to the material of the connector 270 such that force is transferred through the fastener 96 are carried by the reinforcing member 112 and distributed along the surfaces of the reinforcing member 112 to reduce the potential of tear-out of material at the point where the through-hole 294 intersects the lap surface 76. In addition, the presence of the reinforcing member 112 distributes shear forces experienced by the fastener 96 normal to the lap surfaces 76 assisting in the
engagement of the lap surfaces 76 when the panels 30 are loaded with forces normal to the surfaces 78 and 80 of the panel 30.

[0060] In yet another embodiment illustrated in FIGS. 12 and 13, a connector 370 includes a cavity 210 which has a triangular cross-section with internal surfaces which are parallel to the external surfaces of the lap joint portion 74 of the connector 370. The cavity 210 is configured to receive a reinforcing member 212. The reinforcing member 212 functions to distribute loads in a manner similar to reinforcing member 112 of the illustrative embodiments of FIGS. 10 and 11.

[0061] Additional embodiments are shown in FIGS. 7-9. For example, in the illustrative embodiment of FIG. 7, a connector 470 utilizes a panel-engaging portion 172 similar to that of the illustrative embodiment of FIG. 6. However, connector 470 includes a cavity 310, which receives a reinforcing member 312 in the lap joint portion 74, and connector 470 includes a through-hole 594 such that connector 96 may pass therethrough. The reinforcing member 312 in cavity 310 transfers forces in a manner similar to that of the reinforcing member 212 of the connector 370 discussed above.

[0062] In the illustrative embodiment of FIG. 8, a through-hole 694 is oriented to be normal to the lap surface 76, similar to the illustrative embodiment of FIG. 6. However, the connector 570 includes a cavity 410 configured to receive a reinforcing member 412. The fastener 196 is positioned in through-hole 694. As panels 30 are loaded, fastener 196 transfers any additional force normal to the lap surfaces 76, and the reinforcing member 412 thereby distributes those additional forces normal to the lap surface 76 resulting in better gripping between the surfaces 76 to resist separation of the panels 30 in the direction of an arrow 300.

[0063] In the illustrative embodiment of FIG. 9, a connector 670 comprises a panel-engaging portion 172 and a lap joint portion 274. The lap joint portion 274 is similar to lap joint portion 174, but is somewhat elongated such that lap surface 276 of connector 670 is larger than the lap surface 76 of the illustrative embodiments of FIGS. 3-8. The connector 670 includes a cavity 510 configured to receive a reinforcing member 512. The reinforcing member 512 is a plate substantially parallel to surface 78 of panel 30 when the connector 670 is secured to the panel 30. The connector 670 includes a through-hole 794 configured to receive a fastener 96. The reinforcing member 512 is relatively inelastic as compared to the material of connector 670. This allows the reinforcing member 512 to absorb some of the force transferred through the fastener 96 to assist in the prevention of tear-out of an interface of through-hole 794 and interface surface 276 as well as an upper surface 306 of the connector 670.

[0064] In still yet another embodiment shown in FIG. 14, a connector 770 includes a lapping portion 374 and a panel-engaging portion 272. The connector 770 is configured to overlap with a mating connector 770 with a fastener 96 passing through flanges 274 and 276 of the connector 770, through the panel 30, and through a flange 277 of a second connector 770 so that both of the connectors 770 and the panel 30 are all secured by fastener 96.

[0065] The panel-engaging portion 272 of the connector 770 includes a cavity 270. The cavity 270 includes an upper cavity surface 282 and a lower cavity surface 284 which are parallel opposing surfaces separated by a distance which is sufficient to allow the panel 30 to be received in the cavity 270 with the surface 78 and 80 of panel 30 engaging the surfaces 282 and 284 of connector 770. In addition, cavity 270 includes a blind surface 286 that abuts against the panel 30 when the panel 30 is inserted into cavity 270. A through-hole 994 is formed through flange 274 and flange 276. A second through-hole 894 is formed through a flange 288. The panel 30 includes a through-hole 1094. When two connectors 770 are engaged with adjacent panels 30, through-holes 894, 994, and 1094 are positioned so as to be substantially coaxial such that fastener 96 passes through flanges 274, 276, and 288 as well as the panel 30. Thus the panels 30 and connectors 770 are retained together to secure the two panels 30, 30 together. When the connectors 770 are connected together, the respective lap surfaces 376 of each connector 770 are engaged to transfer forces in the manner described in the illustrative embodiments of FIGS. 4-13.

[0066] In yet another embodiment, shown illustratively in FIG. 15, a connector 870 is secured to a panel 30. The connector 870 is similar to connector 170 but further includes a fiber reinforcement structure 872 which is interspersed within the base material of connector 870 to strengthen the connector 870. Adjacent connectors 870 of adjacent panels 30 are retained by a fastener 96 as described in other embodiments above. Fastener 96 is received in a through-hole 1194 to secure the connectors 870.

[0067] In some embodiments, it may be desirable to have a structure to retain panels together without the need for inserting fasteners through the connectors to retain adjacent panels together. A panel assembly 1100, shown in FIGS. 16-20, includes a panel 1118 and a series of connectors 1102, 1104 coupled to the panel 118 at various points about the perimeter of panel 1118 so that adjacent panel assemblies 1101 may be retained together. An upper connector 1102 includes two brackets 1108 coupled to a perimeter surface 1110 of panel 1118. The upper connector 1102 further includes an angle 1106 coupled to the brackets 1108, and having a downwardly facing cavity 1120 along a longitudinal length of angle 1106. Angle 1106 further comprises a relief channel 1112 at an apex of the angle 1106.

[0068] A lower connector 1104 includes two brackets 1116 secured to a perimeter surface 1110 of panel 1118 and spaced apart from the upper connector 1102. A rod 1114 having a circular cross-section is secured between the brackets 1116. Referring to FIG. 18, it can be seen that a lower connector 1104 of a first panel assembly 1100 is positioned to engage an upper connector 1102 of a second panel assembly 1100 and adjacent to the first panel assembly 1100 with the relief channel 1112 of the angle 1106 providing clearance for the rod 1114 to engage with the angle 1106. The length of the upper connector 1102 defined by the distance between brackets 1108 along the perimeter surface 1110 of panel 1118 is slightly smaller than the distance between brackets 1108 of a lower connector 1104 such that upper connector 1102 engages lower connector 1104 without having brackets 1116 interfering with brackets 1108. The downward facing cavity 1120 of upper connector 1102 engages rod 1114 of lower connector 1104 so that the first and second panel assemblies 1100 are positioned adjacent one another.

[0069] Referring now to FIGS. 18-20, a four corner intersection of four panel assemblies 1100 is shown in various
views to illustrate the manner in which a system of panel assemblies 1100 may be assembled to form a connected support surface. Each panel assembly 1100 is constructed in a similar configuration. Therefore, the four corner intersection shown in FIGS. 18-20 shows each of the corners of the panel assembly 1100 engaged with a complementary corner of adjacent panel assemblies 1100. For reference, each of the corners of panel assembly 1100 have been designated by a letter. For example, corner 1100A is positioned adjacent corner 1100D and corner 1100B. Corner 1100C is also positioned adjacent corner 1100D and corner 1100B does not engage with corner 1100A.

[0070] Each corner of panel assembly 1100 has a unique configuration. For example, corner 1100A includes a lower connector 1104 adjacent corner 1100D and an upper connector 1102 adjacent corner 1100B. Corner 1100D includes a lower connector 1104 adjacent to both corners 1100A and 1100C. Corner 1100C includes a lower connector 1104 adjacent corner 1100D and an upper connector 1102 adjacent corner 1100D. When all of the corners are engaged, the four panel assemblies 1100 are engaged in a locking pattern and are appropriately spaced apart from one another.

[0071] Referring again now to FIG. 16, panel assembly 1100 further comprises a connector 1170 coupled to the perimeter surface 1110 and extending laterally therefrom. The connector 1170 includes an oblique surface 1172 which alternately faces upwardly and downwardly about the perimeter of panel assembly 1100 so that adjacent panel assemblies are engaged with an upwardly facing surface 1172 engaging with a downwardly facing surface 1172 of an adjacent panel. The connector 1170 works in a manner similar to the connectors discussed in previous embodiments. Thus, when a system of panels are adjacent, the connectors 1170 assist in transferring forces from one panel assembly 1100 to an adjacent panel assembly 1100 as discussed in the illustrative embodiments of FIGS. 3-5.

[0072] In another embodiment, shown in FIGS. 21-24, a panel assembly 1200 includes a panel 1218 and a connector system including a loop 1202 coupled to a perimeter surface 1210 of panel 1218. The loop 1202 is annular about a vertical axis 1216 and has a circular cross-section. The loop 1202 includes an aperture 1204 oriented perpendicular to the axis 1216. The panel assembly 1200 also includes a hook 1206 spaced apart from the loop 1202. The hook 1206 includes a vertical leg 1212 and a horizontal leg 1208 secured to the perimeter surface 1210 of panel 1218. The hook 1206 is oriented with vertical leg 1212 extending vertically downward from horizontal leg 1208 and hook 1206 is positioned so that vertical leg 1212 is received within the aperture 1204 of a loop 1202 on an adjacent panel assembly 1200 as shown in FIG. 22.

[0073] The loops 1202 and hooks 1206 of panel assembly 1200 are positioned about the perimeter of panel 1218 such that when multiple panel assemblies 1200 are placed adjacent one another, the hooks 1206 and loops 1202 engage to secure the panel assemblies 1200 together. For example, a first panel assembly 1200 is positioned adjacent a second panel assembly 1200 in FIG. 22 with the hook 1206 of the second panel assembly 1200 engaged with the loop 1202 of the first panel assembly 1200. Also shown in FIG. 22 is the engagement of a surface 1172 of a first connector 1170 with the surface 1172 of a second connector 1170.

[0074] Referring now to FIGS. 23 and 24, a four corner intersection of four panel assemblies 1200 is shown. The four corners have been referenced as 1200A, 1200B, 1200C, and 1200D. Each corner has a unique configuration and as the panels are positioned the hooks 1206 and loops 1202 interface to secure the panel assemblies 1200 together to form a system of panels. Also, it should be understood that the lap connectors 1170 engage to assist with the transfer of forces from one panel assembly 1200 to another as described with regard to the panel assembly 1100 discussed above.

[0075] In yet another embodiment, a rectangular panel assembly 1300 includes a series of connector assemblies 1302, 1304, 1306 and 1308 secured to a panel 1310 at each of the four corners of the panel, as shown in FIGS. 27 and 28. While each of the connector assemblies 1302, 1304, 1306 and 1308 have a different configuration, the structure and operation of the connector assemblies 1302, 1304, 1306, and 1308 may be understood by referring to connector assembly 1302 shown in FIGS. 25A and 25B. The connector assembly 1302 includes a corner cap 1312 which receives a corner of the panel 1310 engaging an upper surface 1314 and a lower surface 1316 of the panel 1310. The corner 1312 also engages the perimeter surfaces 1318 of panel 1310.

[0076] The corner cover 1312 includes an outwardly facing surface 1322 which is parallel to perimeter surface 1318 of panel 1310. A bracket 1324 includes a generally rectangular shape with a short side of the rectangular shape secured to surface 1322 such that bracket 1324 extends from surface 1322. The bracket 1324 includes an aperture 1326 communicating through bracket 1324. The aperture 1326 is also rectangular-shaped with sides that are parallel to the perimeter of rectangular bracket 1324. As will be discussed in further detail below, the bracket 1324 is configured to receive a portion of a latchkey 1328 of connector assembly 1304 when a second panel assembly 1300 is placed adjacent to a first panel assembly 1300.

[0077] The corner cover 1312 also includes an outwardly facing surface 1330 which is perpendicular to the surface 1322 and intersects the surface 1322 at the corner of panel assembly 1300. Another bracket 1332 is secured to the surface 1330 and extends perpendicular to the surface 1330. The bracket 1332 is also generally rectangular-shaped having an outer perimeter sized comparably to the bracket 1324 and includes an aperture 1334 communicating through the bracket 1324. The aperture 1334 is offset within the outer perimeter of the bracket 1332 so that the aperture 1334 is positioned near the surface 1330. The bracket 1332 serves as a keeper to maintain the latchkey 1328 in an unlocked position as will be described below.

[0078] The latchkey 1328 is supported within a support 1336 which is also secured to the surface 1330 of the corner cover 1312. The support 1336 includes a rectangular-shaped cross-section when viewed along an axis 1338 which is parallel to the surface 1330. The axis 1338 is parallel to a longitudinal length of the latchkey 1328. The latchkey 1328 moves relative to the support 1336 along the axis 1338 between a locked position shown in FIG. 25A and an unlocked position shown in FIG. 25B. The support 1336 encapsulates a biasing assembly 1340 which biases the latchkey 1328 to the locked position shown in FIG. 25A.

[0079] The biasing assembly 1340 includes a flange 1342 and a bias member 1344. Referring now to FIGS. 25C and
25D, a cross-section of the latchkey 1328, support 1336, bracket 1332, and biasing assembly 1340 is shown. FIG. 25A shows a latchkey 1328 in an unlocked position and FIG. 25B shows the latch 1328 in an unlocked position. The bias member 1344 is positioned within the support 1336 and encloses the portion of latchkey 1328 contained within the support 1336. The flange 1342 is secured to the latchkey 1328 and moves with the latchkey 1328 as the latchkey 1328 moves along the axis 1338. The bias member 1344 is positioned between a surface 1346 of the flange 1342 and an interior surface 1348 of the support 1336. In the illustrative embodiment, the bias member 1344 comprises rubber. It should be understood that the bias member 1344 may comprise any of a number of bias materials such as a compression spring, for example.

[0080] FIG. 25D illustrates the bias member 1344 in a compressed state when the latchkey 1328 is moved to the unlocked position. The compression of the bias member 1344 tends to urge the latchkey 1328 to the unlocked position as shown in FIG. 25C. The latchkey 1328 is permitted to float relative to the support 1336 as it is displaced between the locked and unlocked positions. This allows a guide end 1350 of the latchkey 1328 to move perpendicular to the axis 1338. Once the guide end 1350 is sufficiently displaced through the aperture 1334 of the bracket 1332, the latchkey 1328 can be displaced laterally relative to the axis 1338 such that a notch 1352 can be engaged with the bracket 1332 to retain the latchkey 1328 in the unlocked position. Lateral displacement of the guide end 1350 of the latchkey 1328 releases the latchkey 1328 and the bias member 1342 urges the latchkey 1328 back to the locked position of FIGS. 25A and 25C.

[0081] Referring now to FIG. 26, it can be seen that the connector assembly 1304 includes a latchkey 1328 which is engaged with the bracket 1324 to secure the connector assembly 1302 to the connector assembly 1304. The latchkey 1328 of the connector assembly 1304 is in the locked position such that an upper surface 1354 is engaged with a downwardly facing surface 1356 within the aperture 1326 of the bracket 1324. This prevents movement of the connector 1304 relative to the connector 1302 in four directions. The only movement possible is movement of the connector assemblies 1304 and 1302 relative to each other along the longitudinal length of the latchkey 1328. Also, the support 1336 is engaged with the bracket 1324 to prevent movement of the connector assembly 1304 relative to the connector assembly 1302 in the direction of arrow 1356 as shown in FIG. 26.

[0082] Referring now to FIGS. 27 and 28, when the panel assemblies 1300 are assembled at a corner utilizing each of the connector assemblies 1302, 1304, 1306 and 1308 the group of panels connected is secured such that there is no movement of one connector assembly relative to another connector assembly in any direction thereby forming a single structure.

[0083] Referring now to FIGS. 25C and 25D, an engagement end 1358 of the latchkey 1328 extends from the support 1336 when the latchkey 1328 is in the locked position and is retracted into the support 1336 when the latchkey 1328 is in the unlocked position. In addition to the upper surface 1354, the latchkey 1328 includes a lower surface 1360 and an oblique surface 1362 which is generally downwardly facing. The oblique surface 1362 acts as a cam surface when it is engaged with a bracket of an adjacent connector assembly such as the bracket 1324 of the connector assembly 1302. Thus, as a first panel assembly 1300 is lowered relative to a second panel assembly 1300, surface 1362 engages a top surface 1364 of the bracket 1324 and urges latchkey 1328 to translate along its longitudinal length compressing bias member 1344. The latchkey 1328 is thereby urged away from the bracket 1324 until a tip 1364 of the latchkey 1328 at the intersection of the oblique surface 1362 and top surface 1354 of the latchkey 1328 clears the portion of the latch 1324 above the aperture 1326 at which time the latchkey 1328 is urged to engage with the bracket 1324 through the aperture 1326. The oblique surface 1362 also serves to guide the latchkey 1328 through the aperture 1326 to allow the latchkey 1328 to fully engage with bracket 1324 to connect adjacent panel assemblies 1300 to one another.

[0084] With this configuration of the latchkey 1328, a first panel assembly 1300 may be positioned on the ground and a second panel assembly 1300 may be positioned so that complementary connector assemblies 1302, 1304, 1306, and 1308 are positioned adjacent one another. A second panel assembly 1300 may then be dropped so that latchkey 1328 engages with bracket 1324.

[0085] Multiple panel assemblies 1300 may also be assembled to one another by translating all of the latchkeys 1328 of adjacent panels so that the notch 1352 is engaged with bracket 1332 to retain the latchkey 1328 in the unlocked position. After positioning the adjacent panels, the latchkey 1328 may be disengaged from the brackets 1332 to allow the bias member 1344 to urge the latchkey 1328 to the locked position, engaging with the aperture 1326 of the brackets 1324 on the adjacent complementary connector assemblies.

[0086] To assist with the displacement of the latchkey 1328 to the unlocked position, latchkey 1328 includes an aperture 1366 which passes through latchkey 1328 and is configured to receive a tool 1365 (shown in phantom in FIGS. 25C and 25D) so that a user may utilize the tool to create leverage to move the latchkey 1328 along its longitudinal axis 1338 and laterally displace the latchkey 1328 in the direction of arrow 1367 shown in FIG. 25A when the notch 1352 is positioned to engage with bracket 1332. The tool 1365 may also be used to displace the latchkey 1328 along its longitudinal axis 1338. The latchkey 1328 may then be released when the connector assemblies 1302, 1304, 1306, and 1308 are positioned adjacent one another to thereby secure the panel assemblies 1300 to one another.

[0087] While in the illustrative embodiment of FIGS. 25A-28 multiple connector assemblies 1302, 1304, 1306 and 1308 have been described, it should be understood that the multiple assemblies may be omitted and replaced by a connector 1302 or 1306 positioned at each of the four corners 1300A, 1300B, 1300C and 1300D.

[0088] The connectors 70, 170, 270, 370, 470, 570, 670, 770, 870 and 1170 may be secured to the panels 30, 130, 1118, 1218 and 1310 through any of a number of the fasteners or securing methods. For example, connector 70, 170, 270, 370, 470, 570, 670, 770, 870 and 1170 may be secured to the panels 30, 130, 1118, 1218 and 1310 through a fastener such as screws, nails, bolts, or the like. Connector 70, 170, 270, 370, 470, 570, 670, 770, 870 and 1170 may
also be secured to panels 30, 130, 1118, 1218 and 1310 through other securing means such as welding, heat staking, or any of a number of other securing/adhering methods. In still other embodiments, the connector 70, 170, 270, 370, 470, 570, 670, 770, 870 and 1170 and panels 30, 130, 1118, 1218 and 1310 may be formed as a single unit or any of a number of molding and forming methods. For example, in some embodiments, the connector 70, 170, 270, 370, 470, 570, 670, 770, 870 and 1170 may be formed in an injection molding process or may be machined from a unitary piece of material to form the panels 30, 130, 1118, 1218 and 1310.

[0089] The connectors 70, 170, 270, 370, 470, 570, 670, 770, 870 and 1170 may comprise any of a number of materials such as metal, plastic, rubber, or composite. Materials suitable for extrusion may be utilized including aluminum, various extruded plastics, or rubber such as Rectile 168 EPDM compound. In addition, the connector 70, 170, 270, 370, 470, 570, 670, 770, 870 and 1170 may comprise a fiber reinforced polymer (FRP) such as those described below.

[0090] The panels 30, 130, 1118, 1218 and 1310 may be embodied as one or more high strength composite panels. One exemplary type of composite panel is a fiber reinforced polymer (FRP) panel. Such an FRP panel may be formed of a polymer matrix composite material which includes a reinforcing agent and a polymer resin. The FRP panel may be embodied as any type of FRP structure. Examples of such structures include, but are not limited to, a solid laminate, a sandwich panel (e.g., a panel having upper and lower skins with a core therebetween), a pultruded panel, or a panel having upper and lower skins with vertical or diagonal webs therebetween.

[0091] The matrix may include a thermosetting resin, although thermoplastic resins are also contemplated for use. Examples of thermosetting resins which may be used include, but are not limited to, unsaturated polyesters, vinyl esters, polyurethanes, epoxies, phenolics, and mixtures and blends thereof.

[0092] The reinforcing agent may include E-glass fibers, although other reinforcements such as S-glass, carbon, Kevlar, metal, high modulus organic fibers (e.g. aromatic polyamides, polybenzimidazoles, and aromatic polyimides), and other organic fibers (e.g. polyethylene and nylon) may be used. Blends and hybrids of the various reinforcing materials may be used. Other suitable composite materials may be utilized including whiskers and fibers such as boron, aluminum silicate, and basalt.

[0093] In the case of where the FRP panel is embodied as a sandwich panel, the core type may include, but is not limited to, balsa wood, foam and various types of honeycomb.

[0094] The FRP panel may be embodied as any of the structures disclosed in U.S. Pat. Nos. 5,794,402; 6,023,806; 6,044,607; 6,070,378; 6,081,955; 6,108,998; 6,467,118 B2; 6,645,333; 6,676,785; the entirety of each of which is hereby incorporated by reference. It should be appreciated that the structures disclosed in the above-identified patents may be sized, scaled, dimensioned, orientated, or otherwise configured in any desired manner to fit the needs of a given design of the FRP panel.

[0095] There are a plurality of advantages of the present disclosure arising from the various features of the apparatus and methods described herein. It will be noted that alternative embodiments of the apparatus and methods of the present disclosure may not include all of the features described yet still benefit from at least some of the advantages of such features. Those of ordinary skill in the art may readily devise their own implementations of an apparatus and method that incorporate one or more of the features of the present disclosure and fall within the spirit and scope of the present disclosure.

1. A panel apparatus, comprising:
   a panel, and
   a locking mechanism secured to a perimeter boundary of the panel and extending laterally outwardly from the boundary, the locking mechanism including (i) a latch moveable along the boundary lengthwise relative thereto between first and second positions and (ii) a bias member biasing the latch to the first position.

2. The panel apparatus of claim 1, wherein the locking mechanism further comprises a guide supporting the latch for movement relative thereto.

3. The panel apparatus of claim 2, wherein the latch further comprises a flange and the bias member is positioned between the flange and a portion of the guide.

4. The panel apparatus of claim 3, wherein the bias member comprises an elastomeric sleeve.

5. The panel apparatus of claim 4, the locking mechanism further comprising a retainer configured to be engaged by the latch to maintain the latch in the second position.

6. The panel apparatus of claim 1, the latch further comprising an oblique surface transverse the length of the latch and extending substantially across the latch.

7. A panel apparatus, comprising:
   a first panel, a bracket secured to a perimeter boundary of the first panel, the bracket including an aperture, a second panel, and
   a locking mechanism secured to perimeter boundary of the second panel, the locking assembly including (i) a latch moveable along the perimeter boundary between a locked position and an unlocked position, and (ii) a bias member biasing the latch to the locked position in which the latch is received by the bracket in the aperture to secure the first and second panels to one another.

8. The panel apparatus of claim 7, wherein the locking mechanism further comprises a guide and a retainer and the guide supports the latch for movement relative thereto and the latch is configured to engage with the retainer to maintain the latch in the unlocked position.

9. The panel apparatus of claim 8, wherein the latch translates in a first axis between the locked position and the unlocked position and in a second axis between a position engaging the retainer in the unlocked position and a position disengaged from the retainer.

10. The panel apparatus of claim 9, wherein the latch further comprises a cam surface engaged by a surface of the bracket to displace the latch longitudinally.

11. The panel apparatus of claim 10, wherein the latch further comprises a flange, and the bias member is posi-
tioned between the flange and a portion of the guide to act against the flange to move the flange away from the portion of the guide.

12. The panel apparatus of claim 11, wherein the locking mechanism further comprises a base member secured to the panel, the retainer and guide are secured to the base member, the retainer extends laterally from the base member and defines an aperture therethrough which receives the latch in the unlocked position, the guide extends laterally from the base member, the guide comprises a housing that encloses the bias member and a portion of the latch extending therethrough, and the latch defines (i) a notch which is configured to receive a portion of the retainer when the latch is in the unlocked position to engage with the retainer to maintain the latch in the unlocked position, and (ii) a tool receiving aperture configured to receive a tool to displace the latch relative to the guide.

13. The panel apparatus of claim 12, wherein the first panel, second panel, locking mechanism, and bracket are included in a mat.

14. A panel connector assembly, comprising:

a first portion configured to be secured to a laterally outwardly facing perimeter boundary of a first panel, the first portion including (i) a latch movable along the boundary lengthwise relative thereto between a locked position and an unlocked position and (ii) a bias member biasing the latch to the locked position, and

a second portion configured to be secured to a perimeter boundary of a second panel, the second portion including a latch receiver configured to receive the latch of the first portion when the latch is in the locked position to secure the first and second portions together.

15. The panel connector assembly of claim 14, wherein the latch translates along a longitudinal axis of the latch between the locked and unlocked positions.

16. The panel connector assembly of claim 14, wherein the latch further comprises a cam surface configured to be engaged by a portion of the latch receiver of the second portion when the first portion is engaged with the second portion to displace the latch longitudinally.

17. The panel connector assembly of claim 16, wherein the cam surface extends substantially across the latch.

18. The panel connector assembly of claim 17, wherein the first portion further comprises a guide and a retainer, wherein the guide supports the latch and the bias member is positioned between a portion of the latch and the guide permitting the latch to cant relative to the guide and the retainer is configured to be engaged by the latch in the unlocked position.

19. The panel connector assembly of claim 18, wherein the bias member comprises an elastomeric sleeve at least partially surrounding a portion of the latch.

20. The panel connector assembly of claim 19, wherein the bias member comprises rubber.

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