Abstract: A crane mat is disclosed having a plurality of panels of lumber positioned in alternating transverse directions with respect to one another, where the top and bottom panels are oriented parallel to the direction of vehicular traffic. The top and bottom panels may include a plurality of spaced apart grooves extending longitudinally from a first longitudinal end of the crane mat to a second longitudinal end of the crane mat for enhancing traction of a vehicle when traversing across the crane mat by transporting rain or moisture off the mat, or for receiving mud or other debris. The crane mat may include a plurality of edge protectors positioned on respective sides of the crane mat to protect the crane mat from handling damage. In various embodiments, the crane mat may be manufactured using either softwood, hardwood, or any combination of softwood and hardwood.
CRANE MAT
AND METHOD OF MANUFACTURE

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application claims the benefit of U.S. Provisional Application No. 62/200,508, filed August 3, 2015, and U.S. Provisional Application No. 62/211,651, filed August 28, 2015. Both of these applications are incorporated by reference herein in their entirety.

BACKGROUND

[0002] This application relates generally to the field of temporary roadways and/or ground protection, and more particularly to crane mats and methods and systems for their manufacture.

SUMMARY

[0003] An embodiment of a crane mat is disclosed comprising a plurality of panels positioned in alternating transverse directions with respect to one another. Each of the panels is laminated to an adjacent one of the panels, and each of the panels comprise a plurality of lumber members positioned sided by side. The plurality of lumber members of each panel are oriented in either a longitudinal direction or a transverse direction of the crane mat. The plurality of lumber members in a top panel and a bottom panel of the crane mat are oriented in the transverse direction, which is parallel to a direction of travel of vehicular traffic thereon. In some embodiments, the top and bottom panels include a plurality of spaced apart grooves extending longitudinally from a first longitudinal end of the crane mat to a second longitudinal end of the crane mat for enhancing traction of a vehicle when traversing across the crane mat. The plurality of grooves are positioned longitudinally along a portion of the top and bottom panels of the crane mat. In some embodiments, the crane mat includes an edge protector removably
positioned along at least a portion of respective longitudinal sides of the crane mat. The edge protector includes a U-shaped cross section and a plurality of longitudinal protrusions engaging a plurality of grooves in the top and bottom panels.

[0004] The plurality of panels may include a softwood species, a hardwood species, or any combination of the softwood and the hardwood species. At least one of the plurality of lumber members in the top and bottom panels may include a hardwood species. At least one of the plurality of lumber members in at least one of the panels positioned between the top and bottom panels may include a softwood species. The hardwood species may include at least one of oak, maple, hickory, hackberry, and cherry, and the softwood species may include at least one of spruce, pine, fir, southern yellow pine, and hemlock.

[0005] The plurality of lumber members in at least one of the panels may include a plurality of different widths of lumber positioned side-by-side. At least one of the plurality of lumber members may include a plurality of wooden members fingerjointed together.

[0006] The spaced apart grooves in the top and bottom panels may comprise a depth up to at least approximately one half of a thickness of a respective one of the top and bottom panel. The depth of the spaced apart grooves may vary from the first longitudinal end of the crane mat to the second longitudinal end of the crane mat. At least one of the spaced apart grooves comprises a depth that may vary from the first longitudinal end of the crane mat to the second longitudinal end of the crane mat.

[0007] The edge protector may include a plastic. The edge protector may include a chamfer positioned along top and bottom longitudinal edges. Each of the longitudinal protrusions of the edge protector may include a trapezoidal cross section to ease installation and removal of the edge protector on the top and bottom panels of the crane mat.
Another embodiment of a crane mat having a longitudinal length is disclosed, including: (a) a first panel comprising a plurality of lumber positioned side by side, the plurality of lumber oriented transverse to the longitudinal length of the crane mat, (b) a second panel positioned on top of the first panel, the second panel comprising a plurality of lumber positioned side by side and transverse to the plurality of lumber of the first panel, the second panel being glued to the first panel, (c) a third panel positioned on top of the second panel, the third panel comprising a plurality of lumber positioned side by side and transverse to the plurality of lumber of the second panel, the third panel being glued to the second panel, (d) a fourth panel positioned on top of the third panel, the fourth panel comprising a plurality of lumber positioned side by side and transverse to the plurality of lumber of the third panel, the fourth panel being glued to the third panel, and (e) a fifth panel positioned on top of the fourth panel, the fifth panel comprising a plurality of lumber positioned side by side and transverse to the plurality of lumber of the fourth panel, the fifth panel being glued to the fourth panel.

Another embodiment of a crane mat having a longitudinal length is disclosed, including: (a) a first panel comprising a plurality of lumber positioned side by side, the plurality of lumber oriented transverse to the longitudinal length of the crane mat, (b) a second panel positioned on top of the first panel, the second panel comprising a plurality of lumber positioned side by side and transverse to the plurality of lumber of the first panel, the second panel being glued to the first panel, (c) a third panel positioned on top of the second panel, the third panel comprising a plurality of lumber positioned side by side and transverse to the plurality of lumber of the second panel, the third panel being glued to the second panel, (d) a fourth panel positioned on top of the third panel, the fourth panel comprising a plurality of lumber positioned side by side and transverse to the plurality of lumber of the third panel, the fourth panel being glued to the third panel, and (e) a fifth panel positioned on top of the fourth panel, the fifth panel comprising a plurality of lumber positioned side by side and transverse to the plurality of lumber of the fourth panel, the fifth panel being glued to the fourth panel.
of the fourth panel, the fifth panel being glued to the fourth panel. In this embodiment, the first and fifth panels include a plurality of spaced apart grooves extending longitudinally from a first longitudinal end of the crane mat to a second longitudinal end of the crane mat for transporting rain or moisture, or for receiving mud or other debris therein.

[0010] Another embodiment of a crane mat having a longitudinal length is disclosed, including: (a) a first panel comprising a plurality of lumber positioned side by side, the plurality of lumber oriented transverse to the longitudinal length of the crane mat, (b) a second panel positioned on top of the first panel, the second panel comprising a plurality of lumber positioned side by side and transverse to the plurality of lumber of the first panel, the second panel being glued to the first panel; (c) a third panel positioned on top of the second panel, the third panel comprising a plurality of lumber positioned side by side and transverse to the plurality of lumber of the second panel, the third panel being glued to the second panel; (d) a fourth panel positioned on top of the third panel, the fourth panel comprising a plurality of lumber positioned side by side and transverse to the plurality of lumber of the third panel, the fourth panel being glued to the third panel; (e) a fifth panel positioned on top of the fourth panel, the fifth panel comprising a plurality of lumber positioned side by side and transverse to the plurality of lumber of the fourth panel, the fifth panel being glued to the fourth panel, and (f) an edge protector removably positioned along respective longitudinal sides of the crane mat, the edge protector comprising a U-shaped cross section and a plurality of longitudinal protrusions engaging a plurality of grooves in the first and fifth panels, the plurality of grooves positioned along a portion of respective longitudinal sides of the first and fifth panels.

[0011] Another embodiment of a crane mat having a longitudinal length is disclosed, including: (a) a first panel comprising a plurality of lumber positioned side by side, the plurality of lumber oriented transverse to the longitudinal length of the crane mat, (b) a second panel positioned on top of the first panel, the second panel comprising a plurality of lumber positioned
side by side and transverse to the plurality of lumber of the first panel, the second panel being glued to the first panel, (c) a third panel positioned on top of the second panel, the third panel comprising a plurality of lumber positioned side by side and transverse to the plurality of lumber of the second panel, the third panel being glued to the second panel, (d) a fourth panel positioned on top of the third panel, the fourth panel comprising a plurality of lumber positioned side by side and transverse to the plurality of lumber of the third panel, the fourth panel being glued to the third panel, and (e) a fifth panel positioned on top of the fourth panel, the fifth panel comprising a plurality of lumber positioned side by side and transverse to the plurality of lumber of the fourth panel, the fifth panel being glued to the fourth panel. In this embodiment, the first, second, third, fourth, and fifth panels comprise softwood, hardwood, or any combination of softwood and hardwood species.

[0012] Other embodiments of a crane mat, and variations thereto, are disclosed herein. All of the embodiments of a crane mat disclosed herein may be positioned on the ground for use in the creation of a temporary roadway or platform for vehicles, cranes, construction equipment, and other mobile or stationary machinery. To accommodate relatively wide widths of cranes or other vehicles, crane mats of the instant disclosure are configured for placement on the ground with the long side of each crane mat positioned transverse to the direction of travel of the crane or vehicle thereon. Additional crane mats of the instant disclosure may be positioned in the same orientation with respect to one another, with respective long sides of adjacent crane mats lying adjacent to one another. Crane mats of the instant disclosure may be combined with other mats of different configurations to account for variations in the stability of the ground. For example, crane mats of the instant disclosure may be positioned across timber mats to account for relatively unstable terrain.

[0013] An offset pattern can also be created in the field where crane mats of the instant disclosure are all oriented in the same direction but are positioned in a laterally overlapping
manner with longitudinal ends of adjacent crane mats positioned offset to one another. The relatively shorter side of the crane mats of the instant disclosure being oriented in the direction of travel of the crane or vehicle best approximates the contour of the ground. As a result, tilting or other undesired movement of each crane mat will be minimized as a crane, for example, travels over a temporary roadway formed from a plurality of crane mats of the instant disclosure. Positioning successive crane mats on the ground with the long sides of each mat positioned adjacent one another and the short sides of each mat oriented in the direction of travel makes it easy for a forklift or crane to quickly install each crane mat sequentially in front of one another by using the prior laid crane mat as the roadway or support for the traversing forklift or crane to enable the forklift or crane to position the next one in line. Crane mats positioned in this orientation on the ground allows for the safe and comfortable passage of cranes and other vehicles on undeveloped ground.

[0014] By contrast, orienting multiple crane mats of the instant disclosure side by side to obtain the necessary width to accommodate wide vehicles while orienting the long side of the crane mats in the direction of travel would lead to undesirable tilting, deflection and/or movement of the crane mats as the crane or vehicle travels over the temporary roadway, particularly on ground that slopes upwardly or downwardly in the direction of travel. This orientation will not allow for the safe and comfortable passage of cranes and other vehicles across undeveloped ground.

BRIEF DESCRIPTION OF THE DRAWINGS

[0015] Fig. 1A illustrates one embodiment of a crane mat of the instant disclosure.

[0016] Fig. 1B illustrates a side end view of the embodiment shown in Fig. 1A.

[0017] Fig. 1C illustrates another embodiment of a crane mat of the instant disclosure.
Fig. 1D illustrates a side end view of the embodiment shown in Fig. 1C.

Fig. 1E illustrates another embodiment of a crane mat of the instant disclosure.

Fig. 1F illustrates a side end view of the embodiment shown in Fig. 1E.

Fig. 2A illustrates another embodiment of a crane mat of the instant disclosure.

Fig. 2B illustrates a side end view of the embodiment shown in Fig. 2A.

Fig. 3A illustrates a partial exploded view of another embodiment of a crane mat of the instant disclosure.

Fig. 3B illustrates an unexploded view of the embodiment shown in Fig. 3A.

Fig. 3C illustrates a cross sectional view of the embodiment shown in Fig. 3B.

Figs. 4A and 4B illustrate a block diagram of a method of manufacturing one embodiment of a crane mat of the instant disclosure.

DETAILED DESCRIPTION

Although the figures and the instant disclosure describe one or more embodiments of a crane mat, one of ordinary skill in the art would appreciate that the teachings of the instant disclosure would not be limited to these embodiments. For example, the instant disclosure can also apply to access mats and other temporary roadway or ground protection devices.

Turning now to the drawings wherein like reference numerals refer to like elements, Figs. 1A-1F, 2A-2B, 3A-3C, and 4A-4B illustrate exemplary embodiments and methods of manufacture of a crane mat comprising a plurality of panels for use in the creation of a
temporary roadway or platform for vehicles, cranes, construction equipment, and other mobile or stationary machinery.

[0029] As shown in the embodiment of Figs. 1A-1B, crane mat 100 includes panels 102, 104, 106, 108, 110. In other embodiments, crane mat 100 may be configured with any number of panels from a minimum of one panel to a maximum of thirteen panels to provide a desired strength and/or operating performance. In this embodiment, panel 102 is positioned on top of panel 104, which is positioned on top of panel 106, which is positioned on top of panel 108, which is positioned on top of panel 110. In other embodiments, panel 110 may be positioned on top of panel 108, which may be positioned on top of panel 106, which may be positioned on top of panel 104, which may be positioned on top of panel 102. In use, crane mat 100 may be fully reversible, with either of panels 102 or 110 acting as the working surface for receiving vehicles, cranes, construction equipment or other mobile or stationary machinery, and with the other of panels 102 or 110 being configured for placement on, for example, the ground, a roadway, a ramp, a platform or other crane mat or object.

[0030] In this embodiment, panel 102 is glued to panel 104, panel 104 is glued to panel 106, panel 106 is glued to panel 108, and panel 108 is glued to panel 110. In other embodiments, panels 102, 104, 106, 108, and 110 are connected to one another using bolts, screws, straps, clips, or other fastening or joining techniques or any combination of them. In this embodiment, each of panels 102, 106, 110 is oriented in a first direction and panels 104, 108 are oriented in a second direction approximately 90 degrees relative to panels 102, 106, 110. In other embodiments, panels 102, 104, 106, 108, and 110 may be oriented at any angle relative to one another, including all panels lying in the same direction, to provide a desired strength and/or operating performance of crane mat 100. In one embodiment, at least two adjacent panels of the crane mat are aligned in approximately the same direction (see, e.g., Figs. 1C-1F). The
overall strength and rigidity of crane mat 100 is likely maximized, however, by alternating the
direction of respective adjacent panel layers.

[0031] In this embodiment, each of panels 102,106,110 includes a plurality of members 112
positioned side-by-side along respective side ends 115. Each member 112, and particularly
each side end 115 of each member 112, is oriented in the first direction. For purposes of this
disclosure, the first direction is oriented parallel to the general direction of travel of vehicular
traffic on crane mat 100. As shown in Figs. 1A-1 B, the length "L1" of each member 112 is
longer than a width "W1" of each member 112, and the width of each member 112 is longer
than a depth or height "H1" of each member 112. Although members 112 are shown in the
figures as being of the same length "L1," in other embodiments, for each member 112, the
length "L1" thereof may comprise a plurality of separate members that together result in
achieving the length "L1" for each member 112. In addition, it should be understood that the
combination of members that form each member 112 may vary in length from one to another.
Such combination of members forming each member 112 in such other embodiments may be
spliced or joined together using any number of techniques, including fingerjointing, lap jointing,
rabbit jointing, tongue and groove jointing, miter joining and the like, or they may simply be
positioned adjacent one another to form a butt joint. In this way, pieces of lumber having
differing lengths can be pieced together to form each member 112.

[0032] In this embodiment, each of panels 104,108 includes a plurality of members 114
positioned side-by-side along respective side ends 117. Each member 114, and particularly
each side end 117 of each member 114, is oriented in the second direction. As shown in Figs.
1A-1 B, the length "L2" of each member 114 is longer than a width "W2" of each member 114,
and the width of each member 114 is longer than a depth or height "H 2" of each member 114.
Consequently, in this embodiment, the length of each member 114 of each of panels 104,108 is
oriented in the second direction, which is 90 degrees relative to the first direction and transverse
to the general direction of travel of vehicular traffic on crane mat 100. In addition, as shown in Figs. 1A-1B, in this embodiment, the length of members 114 is greater than the length of members 112, whereas the width and height of members 114 and members 112 are approximately the same as one another. Although members 114 are shown in the figures as being of the same length "L2," in other embodiments, for each member 114, the length "L2" thereof may comprise a plurality of separate members that together result in achieving the length "L2" for each member 114. In addition, it should be understood that the combination of members that form each member 114 may vary in length from one to another. Such combination of members forming each member 114 in such other embodiments may be spliced or joined together using any number of techniques, including fingerjointing, lap jointing, rabbit jointing, tongue and groove jointing, miter joining and the like, or they may simply be positioned adjacent one another to form a butt joint. In this way, pieces of lumber having differing lengths can be pieced together to form each member 114.

[0033] In this embodiment, members 114 are generally aligned in a longitudinal direction (i.e., the second direction) of crane mat 100, and members 112 are generally aligned transverse (i.e., in the first direction) to members 114. Thus, in this embodiment, the length of members 114 defines the longitudinal length of crane mat 100, and the length of members 112 defines the transverse width of crane mat 100, where length "L2" is longer than length "L1". For vehicular traffic moving across crane mat 100 in the first direction and transverse to the longitudinal direction of crane mat 100, members 112 of panel 102 (or panel 110 if oriented upside down as compared to the orientation shown in Figs. 1A-1B) will be oriented to maximize resistance to wear and damage that may be caused by vehicular traffic over crane mat 100, resulting in longer crane mat life and reduced costs. In other words, vehicular traffic coming upon crane mat 100 will strike a longitudinal end of various members 112 in panel 102 (or panel 110 if oriented upside down) where the end grain of the lumber is exposed. The end grain of
members 112 provides superior resistance to wear and tear from vehicle traffic, and particularly in comparison to vehicle movement in the second, longitudinal direction of crane mat 100. In addition, because the majority of the panels in crane mat 100 comprise members 112 having length "L1" that is shorter than members 114 having length "L2", crane mat 100 may contour to the actual surface of the ground, and will result in a lower weight crane mat that reduces shipping costs.

[0034] In one embodiment, crane mat 100 is configured to be approximately 4 feet wide in the first, transverse direction and 16 feet long in the second, longitudinal direction. In another embodiment, crane mat 100 is configured to be approximately 4 feet wide in the first, transverse direction and 18 feet long in the second, longitudinal direction. In another embodiment, crane mat 100 is configured to be approximately 4 feet wide in the first, transverse direction and 20 feet long in the second, longitudinal direction. In another embodiment, crane mat 100 is configured to be approximately 4 feet wide in the first, transverse direction and 22 feet long in the second, longitudinal direction. In yet another embodiment, crane mat 100 is configured to be approximately 4 feet wide in the first, transverse direction and 24 feet long in the second, longitudinal direction. In other embodiments, crane mat 100 may have a width that is smaller or larger than 4 feet and a length that is shorter or longer than 16 feet. In use, multiple crane mats 100 may be abutted adjacent one another or attached to one another along the long side of crane mat 100 to orient the short side of crane mat 100 and particularly members 112 so as to be positioned in the direction of vehicle movement. In this way, the long side of the crane mat is positioned to accommodate wide vehicles traveling parallel to the orientation of members 112.

[0035] In some embodiments, members 112 are glued or otherwise adhered to one another along respective side ends 115, and members 114 are glued or otherwise adhered to one another along respective side ends 117. In other embodiments, members 112 are connected to
one another, and members 114 are connected to one another, using bolts, screws, straps, clips, or other fastening or joining techniques or any combination of them.

[0036] In this embodiment, each of members 112 is approximately the same geometry as one another in terms of width, depth, and length. In other embodiments, the width, depth and/or length of members 112 may vary from one to another but may be machined to form finished panels 102,106,110 for crane mat 100. In this embodiment, each of members 114 is approximately the same geometry as one another in terms of width, depth, and length. In some embodiments, the width, depth and/or length of members 114 may vary from one to another but may be machined to form finished panels 104,108 for crane mat 100.

[0037] In some embodiments, members 112,114 may include dimensional lumber, including 1x4, 1x6, 1x8, 1x10, 1x12, 2x4, 2x6, 2x8, 2x10, and 2x12. In some embodiments, for any given panel, members 112,114 may comprise the same width of lumber positioned side-by-side to create the panel. In other embodiments, for any given panel, members 112,114 may comprise different or variable widths of lumber positioned side-by-side to create the panel. In yet other embodiments, for any given panel, members 112,114 may comprise any combination of the same and different widths of lumber positioned side-by-side to create the panel. Members 112,114 of one or more panels of crane mat 100 may include softwood lumber comprising, for example, spruce, pine, fir, southern yellow pine, or hemlock, hardwood lumber comprising, for example, oak, maple, hickory, hackberry, or cherry, or any combination of softwood or hardwood. For any given member 112,114, a hardwood species, such as oak, may lie adjacent to a different hardwood species, such as hickory, and a softwood species, such as pine, may lie adjacent to a different softwood species, such as fir. In some embodiments, a hardwood panel comprising members 112 or 114 may comprise hardwood lumber 1 inch thick with lumber comprising different widths positioned side-by-side. In other embodiments, a softwood panel comprising members 112 or 114 may comprise softwood lumber 2 inches thick with lumber
comprising different widths positioned side-by-side. In some embodiments, a panel made of one or more hardwood species of lumber may be positioned adjacent above or below and glued to a panel made of one or more softwood species of lumber. In other embodiments, members 112,114 may include any material in any stock dimension suitable for creating a temporary roadway, including a plastic, a composite, or a metal.

[0038] Turning to Figs. 1C-1D, there is shown another embodiment of crane mat 100. In particular, panel 106 is replaced by panel 111 having a plurality of members 114 positioned side-by-side along respective side ends 117. Each member 114 of panel 111 is oriented in a longitudinal direction (i.e., the second direction) of crane mat 100. However, as shown in Fig. 1D, each of members 114 of panel 111 are positioned laterally offset in the first direction relative to respective members 114 in adjacent panels 104,108. The offset side ends 117 of members 114 of respective panels 104,111,108 provide enhanced lateral stiffness of crane mat 100 in the first direction while permitting enhanced longitudinal flexibility in the second direction than the embodiment of crane mat 100 shown in Figs. 1A-1B.

[0039] Figs. 1E-1F show yet another embodiment of crane mat 100. In this embodiment, panels 106,108 are replaced in their entirety by panel 111 having a plurality of members 114 positioned side-by-side along respective side ends 117 to form a four panel embodiment of crane mat 100. Like the embodiment shown in Figs. 1C-1D, each member 114 of panel 111 is oriented in a longitudinal direction (i.e., the second direction) of crane mat 100. Similarly, each of members 114 of panel 111 are positioned laterally offset in the first direction relative to respective members 114 in adjacent panel 104. The offset side ends 117 of members 114 of respective panels 104,111 provide enhanced lateral stiffness of crane mat 100 while permitting enhanced longitudinal flexibility than the embodiment of crane mat 100 shown in Figs. 1C-1D. In addition, in applications where increased longitudinal flexibility is desired over the embodiment shown in Figs. 1C-1D, the embodiment of Figs. 1E-1F provides the added benefits
of: (1) reduced fabrication costs due to less material and fewer manufacturing processes needed to produce crane mat 100; (2) reduced transportation costs due to lighter weight finished product and smaller finished product volume, which permits shipping more crane mat units in a single freight transportation container, and (3) easier handling by users due to lighter weight of the finished product.

Turning to Figs. 2A-2B, there is shown another embodiment of a crane mat. Crane mat 200 includes all of the same features, characteristics, and variations described above for crane mat 100 with the addition of a plurality of slots or grooves 201 disposed on the top panel 202 and/or bottom panel 210 of crane mat 200 for enhancing vehicle traction when traversing across crane mat 200 parallel to the orientation of members 212. In this embodiment, panels 202,204,206,208,210 of crane mat 200 are identical to panels 102,104,106,108,110 of crane mat 100 except that panel 202 is shown as including grooves 201 disposed thereon. In some embodiments, crane mat 100 may include grooves 201 as described in more detail below.

As best shown in Fig. 2B, grooves 201 may comprise generally vertical opposing sidewalls 205 and a generally horizontal bottom wall 203. In other embodiments, grooves 201 may comprise a U-shape (with or without a rounded bottom wall), a V-shape, a trapezoidal shape, a semi-circular shape, or any other shape or combination thereof that enhances vehicle traction. In this embodiment, crane mat 200 includes 9 slots or grooves 201 positioned on top panel 202 (and bottom panel 210 to provide reversibility of crane mat 200), though a greater or fewer quantity of grooves 201 are possible.

Grooves 201 may comprise any width and any spacing that permits a desired number of grooves 201 to be positioned on panel 202,210. Grooves 201 may comprise any depth up to at least approximately one half of the thickness of panel 202. In one embodiment, grooves 201 comprise a depth from about 0.100" to about 0.75". In one embodiment, grooves
201 comprise a depth of about 0.25" +/- 0.150". In another embodiment, grooves 201 comprise a depth of about 0.50". In another embodiment, grooves 201 comprise a depth of about 0.75". Grooves may vary in depth from one end of crane mat 200 to another end of crane mat to enhance drainage of water from crane mat 200. Grooves 201 may also vary in depth from any point along crane mat 200 relative to any other point along crane mat 200. For example, the depth of grooves 201 may be more shallow in the middle of crane mat 200 and progressively deeper toward the periphery to enhance drainage of water from crane mat 200.

[0043] In this embodiment, grooves 201 are generally aligned in a longitudinal direction of crane mat 200 and transverse to members 212, which are generally aligned transverse to members 214. In this embodiment, the length of members 214 defines the longitudinal length of crane mat 200, and the length of members 212 define the transverse width of crane mat 200. For vehicular traffic moving across crane mat 200 parallel to the orientation of members 212 (i.e., in the first direction) and transverse to the longitudinal direction of crane mat 200, transversely aligned members 212 of panel 202 (or panel 210 if grooves 201 are also positioned thereon and if panel 210 is oriented upside down as compared to the orientation shown in Figs. 2A-2B) will be oriented to maximize resistance to wear and damage that may be caused by vehicular traffic over crane mat 200 while grooves 201 provide for rain, moisture, mud or other debris to collect therein and drain therefrom to enhance traction of the vehicle. In other embodiments, grooves 201 may be oriented in any angle on panel 202 and/or 210. In some embodiments, the angle of grooves 201 relative to other grooves 201 form a pattern on panel 202 and/or 210.

[0044] Turning to Figs. 3A-3C there is shown another embodiment of a crane mat. Crane mat 300 includes all of the same features, characteristics, and variations described above for crane mat 100 with the addition of a plurality of slots or grooves 301, 311 disposed on the top panel 302 and/or bottom panel 310 of crane mat 300. In this embodiment, panels
of crane mat 300 are identical to panels 102,104,106,108,110 of crane mat 100 except that panel 302 is shown as including grooves 301,311 disposed thereon. In some embodiments, crane mat 100 may include grooves 301,311 as described in more detail below.

[0045] In this embodiment, grooves 301 are disposed along the first and last members 312 on top panel 302 and/or the first and last members 312 on bottom panel 310 near the periphery of crane mat 300. Grooves 301 provide a means for attaching accessories for joining adjacent mats together and for handling and manipulation of crane mat 300 at, for example, the job site. Grooves 301 may also provide a means for engaging with an embodiment of protectors 350 (discussed below) for protecting at least a portion of a longitudinal end of crane mat 300 during handling and use. In this embodiment, grooves 301 are shown as extending along a portion of members 312. In other embodiments, grooves 301 may extend from one end to the other end of member 312.

[0046] In this embodiment, grooves 311 are disposed on top panel 302 and bottom panel 310 longitudinally and transverse to members 312, which are generally aligned transverse to members 314, near the periphery of crane mat 300. Grooves 311 extend along a portion of the periphery of crane mat 300 for limiting the longitudinal motion of protectors 350 (discussed below) when engaged thereto.

[0047] Grooves 311 may comprise generally vertical opposing sidewalls 305 and a generally horizontal bottom wall 303. In other embodiments, grooves 311 may comprise a U-shape (with or without a rounded bottom wall), a V-shape, a trapezoidal shape, a semi-circular shape, or any other shape or combination thereof that enables engagement with protrusions 355 of protectors 350. Grooves 311 may comprise any depth up to approximately one half of the thickness of panel 302,310. In one embodiment, grooves 311 comprise a depth from about
0.100" to about 0.75". In one embodiment, grooves 311 comprise a depth of about 0.25" +/-
0.150". In another embodiment, grooves 311 comprise a depth of about 0.50". In another
embodiment, grooves 311 comprise a depth of about 0.75".

[0048] In this embodiment, crane mat 300 also includes protectors 350 that are removably
positionable along the longitudinal sides of crane mat 300. Protectors 350 are configured for
protecting at least a portion of a longitudinal side of crane mat 300 during handling and use. In
this embodiment, crane mat 300 includes two protectors 350. In other embodiments, crane mat
300 may include a greater or fewer number of protectors 350, and crane mat 300 may include a
greater or fewer number of grooves 311. Protectors 350 may include a longitudinal chamfer
360 of sufficient size along top and bottom outer edges to permit, for example, a forklift operator
to easily insert a forklift blade between two adjacentely positioned crane mats 300 having
protectors 350 thereon and to separate the two crane mats 300 for subsequent lifting or
handling operations.

[0049] Protectors 350 may comprise a U-shape to mount over at least a portion of a
longitudinal side of crane mat 300. In other embodiments, protectors 350 may be configured to
mount over at least a portion of a transverse side of crane mat 300. In such embodiments,
protectors 350 may be configured to engage with grooves 301. In this embodiment, protectors
350 are configured for attachment to crane mat 300 via protrusions 355 that are configured to
engage with grooves 311. In other embodiments, protectors 350 are configured for attachment
to crane mat 300 via an interference fit with crane mat 300.

[0050] In this embodiment, protrusions 355 are configured with at least one longitudinal
chamfer 365 to permit relatively easy installation and removal of protectors 350 from crane mat
300 when, for example, damage to protector 350 occurs necessitating its replacement. In some
embodiments, protrusions 355 have a trapezoidal cross sectional shape.
Protectors 350 may be fabricated from any plastic, including polyethylene, polypropylene, polystyrene, polyamide, polyvinyl chloride, and polycarbonate. Protectors 350 may be fabricated from any metal, including steel and aluminum. Protectors 350 may be fabricated from any composite material, including fiber reinforced plastics and metal composites. Protectors 350 may be fabricated from extrusions, injection moldings, stampings, laminations, forgings, castings, and the like.

Turning to Figs. 4A-4B, there is shown one embodiment of a method of making a crane mat of the present disclosure comprising an apparatus or system 400. It should be understood that other types of vehicle or ground protection mats, including access mats, can be manufactured by system 400 using the method disclosed herein. In various embodiments, one or more aspects of system 400 can be merged with one another, omitted, or made part of additional apparatuses or system components. These systems may be configured to fabricate a crane mat billet, which may be further cut or trimmed to meet customer specifications.

Dimensional lumber is loaded into or by system 400 at Step 410 of system 400. One or more surfaces of the lumber are planed by a planar apparatus at Step 412 of system 400. System 400 is configured to stack lumber at Step 414 according to size for later retrieval. At Step 416, system 400 loads a composite sheet for a carrier apparatus of system 400, after which lumber is loaded side-by-side for a bottom panel of a crane mat at Step 418.

System 400 may be configured to apply glue to a top surface of the bottom panel in a manner that minimizes adhesive material cost, which may otherwise be a significant expense in the construction of a crane mat. In some embodiments, the panel is moved or conveyed under a stationary glue dispensing apparatus while glue is dispensed from the glue dispensing apparatus onto the panel. In other embodiments, the panel is held stationary while the glue dispensing apparatus traverses over the panel and dispenses glue onto the panel. In some
embodiments, a continuous (or in some embodiments a discontinuous) ribbon of glue is applied along the perimeter of a given panel while a solid or a stitched pattern of rows of adhesive is applied to the interior, central area of the top surface of the panel. In one embodiment, system 400 includes stationary adhesive nozzles (or other glue dispensing apparatus) positioned in a row transverse to the longitudinal orientation of the panel. As the panel is conveyed longitudinally by a conveyer, system 400 at Step 420 applies a solid glue line along the lateral and longitudinal perimeter of the top surface of the bottom panel while system 400 at Step 422 simultaneously applies a solid and/or a stitched or intermittent glue line along the central area of the top surface of the bottom panel. If a stitched or intermittent glue line is applied, the interval between glue dots or dashes in the central area is dependent on the speed at which the panel is conveyed under the nozzles as well as the pulse duration of the dispensing of glue from the nozzles. In another embodiment, system 400 includes traversing adhesive nozzles (or other glue dispensing apparatus) positioned in a row transverse to the longitudinal orientation of the panel. As the adhesive nozzles traverse over the stationary panel, system 400 at Step 420 applies a solid glue line along the lateral and longitudinal perimeter of the top surface of the bottom panel while system 400 at Step 422 simultaneously applies a solid and/or a stitched or intermittent glue line along the central area of the top surface of the bottom panel. If a stitched or intermittent glue line is applied, the interval between glue dots or dashes in the central area is dependent on the speed at which the adhesive nozzles traverse over the panel as well as the pulse duration of the dispensing of glue from the nozzles.

[0055] At Step 424, the same glue application technique is performed by system 400 to the next succeeding panel, which will be oriented transverse to the bottom panel, and which is stacked upon the bottom panel. The load, stacking, and gluing process of Steps 418, 420, 422, and 424 is repeated at Steps 426 and 428 for the additional panels that will be stacked to form the desired crane mat. An assembled plurality of laminated, composite panels of a crane mat
are then stacked on top of an additional plurality of composite panels of separate crane mats at Steps 430, 432, 434, and 436 and all are pressed in a press system of system 400 at Step 438. In some embodiments, 3 or 4 sets of crane mats may be pressed at one time in this way. In other embodiments, a greater or fewer number of crane mats may be pressed at the same time.

[0056] At Steps 440, 442, and 444 the composite panels are removed from the press system of system 400 and separated from one another. At Step 446, the composite panels of a particular crane mat are cut by one or more cutting machines of system 400 to a desired finished length and width. At Step 448, the various edges of the crane mat may optionally be beveled by system 400. For various embodiments of crane mats, at Step 450 one or more routers or plunge cutters of system 400 are configured to cut optional grooves 301,311 discussed above on either or both of the top or bottom surfaces of the crane mat. For various embodiments of crane mats, at Step 452 one or more routers or plunge cutters of system 400 are configured to cut optional grooves 201 on either or both of the top or bottom surfaces of the crane mat. At Step 454, system 400 is configured to optionally paint or seal one or more sides of the crane mat. At Step 456, the completed crane mat having the desired configuration is moved to inventory.

[0057] One or more aspects of system 400 are operable by one or more computers and/or one or more programmable logic controllers (PLC’s). The computers and/or PLC’s may be coupled with one or more sensors configured for reporting position, measurements, status, and other data regarding elements of system 400 and the crane mats being fabricated, and motors, actuators and the like for controlling the operation of one or more aspects of system 400. The computers and/or PLC's may be connected to one another and to other computers or devices via a wired or wireless network. These devices may be connected to one or more remote computers and/or web servers via a wired or wireless connection to the Internet.
The computers and one or more PLC's include a processor, such as a central processing unit (CPU), for executing software, particularly software stored in memory or on any computer readable medium, for use by or in connection with any computer related system or method.

A computer readable medium includes any electronic, magnetic, optical, or other physical device or apparatus that can contain or store a computer program for use by or in connection with a computer related system or method. Memory can include any one or a combination of volatile memory elements (e.g., random access memory (RAM, such as DRAM, SRAM, SDRAM, etc.)) and nonvolatile memory elements (e.g., ROM, hard drive, tape, CDROM, etc.). Moreover, memory may incorporate electronic, magnetic, optical, and/or other types of storage media. Memory can have a distributed architecture where various components are situated remote from one another, but are still accessed by a processor.

The software may include one or more separate programs comprising ordered listings of executable instructions for implementing logical functions. The software stored in memory or on any computer readable medium may include one or more computer programs, each including executable instructions executed by the processor. An operating system may control the execution of other computer programs and can provide scheduling, input-output control, file and data management, memory management, and communication control and related services.

In one embodiment, the PLC may include a computer processor such as a central processing unit (CPU), memory, operating software stored in memory, and various input and output (I/O) devices or data paths. The I/O devices may include input devices, such as a keyboard, mouse, touch screen, and/or any other user interface. The I/O devices may also include output devices, such as a computer display, a modem, a router, serial and parallel wired
and wireless communication components and any other elements needed to connect to, for
example, another computer or device via a local network or the Internet whether wired or
wirelessly. The I/O devices may further include any element or device in a feedback control
system for controlling the operation and performance of any aspect of system 400.

[0062] While specific embodiments have been described in detail, it will be appreciated by
those skilled in the art that various modifications and alternatives to those details could be
developed in light of the overall teachings of the disclosure. Accordingly, the disclosure herein
is meant to be illustrative only and not limiting as to its scope and should be given the full
breadth of the appended claims and any equivalents thereof.
CLAIMS

What is claimed is:

1. A crane mat, comprising:
   a plurality of panels positioned in alternating transverse directions with respect to one another, each of the panels laminated to an adjacent one of the panels and comprising a plurality of lumber members positioned side by side, the plurality of lumber members of each panel oriented in either a longitudinal direction or a transverse direction of the crane mat, wherein the plurality of lumber members in a top panel and a bottom panel of the crane mat are oriented in the transverse direction.

2. The crane mat of Claim 1, wherein the plurality of panels comprises a softwood species, a hardwood species, or any combination of the softwood and the hardwood species.

3. The crane mat of Claim 2, wherein at least one of the plurality of lumber members in the top and bottom panels comprises the hardwood species, and wherein at least one of the plurality of lumber members in at least one of the panels positioned between the top and bottom panels comprises the softwood species.

4. The crane mat of Claim 3, wherein the hardwood species comprises at least one of oak, maple, hickory, and hackberry.

5. The crane mat of Claim 3, wherein the softwood species comprises at least one of spruce, pine, fir, southern yellow pine, and hemlock.

6. The crane mat of Claim 1, wherein the plurality of lumber members in at least one of the panels comprises a plurality of different widths of lumber positioned side-by-side.
7. The crane mat of Claim 1, wherein at least one of the plurality of lumber members comprises a plurality of wooden members fingerjointed together.

8. A crane mat, comprising:

   a plurality of panels positioned in alternating transverse directions with respect to one another, each of the panels laminated to an adjacent one of the panels and comprising a plurality of lumber members positioned side by side, the plurality of lumber members of each panel oriented in either a longitudinal direction or a transverse direction of the crane mat, wherein the plurality of lumber members in a top panel and a bottom panel of the crane mat are oriented in the transverse direction, wherein the top and bottom panels include a plurality of spaced apart grooves extending longitudinally from a first longitudinal end of the crane mat to a second longitudinal end of the crane mat for enhancing traction of a vehicle when traversing across the crane mat.

9. The crane mat of Claim 8, wherein the plurality of panels comprise a softwood species, a hardwood species, or any combination of the softwood and the hardwood species.

10. The crane mat of Claim 9, wherein at least one of the plurality of lumber members in the top and bottom panels comprises the hardwood species, and wherein at least one of the plurality of lumber members in at least one of the panels positioned between the top and bottom panels comprises the softwood species.

11. The crane mat of Claim 10, wherein the hardwood species comprises at least one of oak, maple, hickory, and hackberry.

12. The crane mat of Claim 10, wherein the softwood species comprises at least one of spruce, pine, fir, southern yellow pine, and hemlock.
13. The crane mat of Claim 8, wherein the plurality of lumber members in at least one of the panels comprises a plurality of different widths of lumber positioned side-by-side.

14. The crane mat of Claim 8, wherein at least one of the plurality of lumber members comprises a plurality of wooden members fingerjointed together.

15. The crane mat of Claim 8, wherein the spaced apart grooves comprise a depth up to at least approximately one half of a thickness of a respective one of the top and bottom panel.

16. A crane mat, comprising:

   a plurality of panels positioned in alternating transverse directions with respect to one another, each of the panels laminated to an adjacent one of the panels and comprising a plurality of lumber members positioned side by side, the plurality of lumber members of each panel oriented in either a longitudinal direction or a transverse direction of the crane mat, wherein the plurality of lumber members in a top panel and a bottom panel of the crane mat are oriented in the transverse direction; and

   an edge protector removably positioned along at least a portion of respective longitudinal sides of the crane mat, the edge protector comprising a U-shaped cross section and a plurality of longitudinal protrusions engaging a plurality of grooves in the top and bottom panels, the plurality of grooves positioned longitudinally along a portion of the top and bottom panels.

17. The crane mat of Claim 16, wherein the plurality of panels comprise a softwood species, a hardwood species, or any combination of the softwood and the hardwood species.
18. The crane mat of Claim 17, wherein at least one of the plurality of lumber members in the top and bottom panels comprises the hardwood species, and wherein at least one of the plurality of lumber members in at least one of the panels positioned between the top and bottom panels comprises the softwood species.

19. The crane mat of Claim 18, wherein the hardwood species comprises at least one of oak, maple, hickory, and hackberry.

20. The crane mat of Claim 18, wherein the softwood species comprises at least one of spruce, pine, fir, southern yellow pine, and hemlock.

21. The crane mat of Claim 16, wherein the plurality of lumber members in at least one of the panels comprises a plurality of different widths of lumber positioned side-by-side.

22. The crane mat of Claim 16, wherein at least one of the plurality of lumber members comprises a plurality of wooden members fingerjointed together.

23. The crane mat of Claim 16, wherein the edge protector comprises a plastic.

24. The crane mat of Claim 16, wherein the edge protector includes a chamfer positioned along top and bottom longitudinal edges.

25. The crane mat of Claim 16, wherein each of the longitudinal protrusions include a trapezoidal cross section to ease installation and removal of the edge protector on the top and bottom panels.
FIG. 4A

400

Load Lumber 410

Plane Boards One or two sides 412

Stack Lumber by Size 414

Load composite sheet for short board carrier 416

Load Lumber Layer 418

Distribute solid glue lines on edge of panel 420

Distribute solid glue lines or stitch segmented glue lines on center of panel 422

Apply Next Layer 424

Repeat for 3-5 Layers 426

Complete Assembly? 428

No

Yes

Load composite sheet for short board carrier 430

A

B
3-4 CLT Panels Loaded?

Yes

Move to Press

Load Multiple panels in press (3-4)

Apply Pressure

Remove from Press

Separate laminated panels from composite sheets

Return laminated sheets to panel assembly

Cut individual panels to width and length

Cut Beveled Edges

Plunge Cut Accessory Track

Cut Non Skid Surface on top and bottom of Mat

Paint/Seal four sides

Move mats to inventory

No
**INTERNATIONAL SEARCH REPORT**

**A. CLASSIFICATION OF SUBJECT MATTER**

<table>
<thead>
<tr>
<th>IPC(8)</th>
<th>CPC</th>
<th>According to International Patent Classification (IPC) or to both national classification and IPC</th>
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<td>E01C 5/14 (2015.12)</td>
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**B. FIELDS SEARCHED**

Minimum documentation searched (classification system followed by classification symbols)

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<th>USPC</th>
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Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

- Orbit, Google Patents, Google
- Search terms used: crane mat, wood, alternating, edge, protect, hardwood, softwood

**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

<table>
<thead>
<tr>
<th>Category*</th>
<th>Citation of document, with indication, where appropriate, of the relevant passages</th>
<th>Relevant to claim No.</th>
</tr>
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<tbody>
<tr>
<td>X</td>
<td>STERLING LUMBER. Access Mat 3 Ply Video Final. Youtube. 21 April 2014. [retrieved 27 December 2015], Retrieved via the internet: &lt;URL: <a href="https://www.youtube.com/watch?v=ZVRyZIOI05E%3E">https://www.youtube.com/watch?v=ZVRyZIOI05E&gt;</a>. entire video</td>
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<tr>
<td>Y</td>
<td>US 8,066,447 B2 (BRANDSTROM) 29 November 2011 (29.11.2011) entire document</td>
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<tr>
<td>Y</td>
<td>US 3,730,820 A (FIELDS et al) 01 May 1973 (01.05.1973) entire document</td>
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**Further documents are listed in the continuation of Box C.**

**See patent family annex.**

* Special categories of cited documents:
  - "A" document defining the general state of the art which is not considered to be of particular relevance
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  - "O" document referring to an oral disclosure, use, exhibition or other means
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  - "&" document member of the same patent family

**Date of the actual completion of the international search**

28 December 2015

**Date of mailing of the international search report**

27 JAN 2016

**Name and mailing address of the ISA/**

Mail Stop PCT, Attn: ISA/US, Commissioner for Patents
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**Authorized officer**

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Form PCT/ISA/210 (second sheet) (January 2015)