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Valle

(54) **TILT-WALL PANEL**

(76) Inventor: **John Valle**, Laredo, TX (US)

Correspondence Address:
FULBRIGHT & JAWORSKI L.L.P.
600 CONGRESS AVE., SUITE 2400
AUSTIN, TX 78701 (US)

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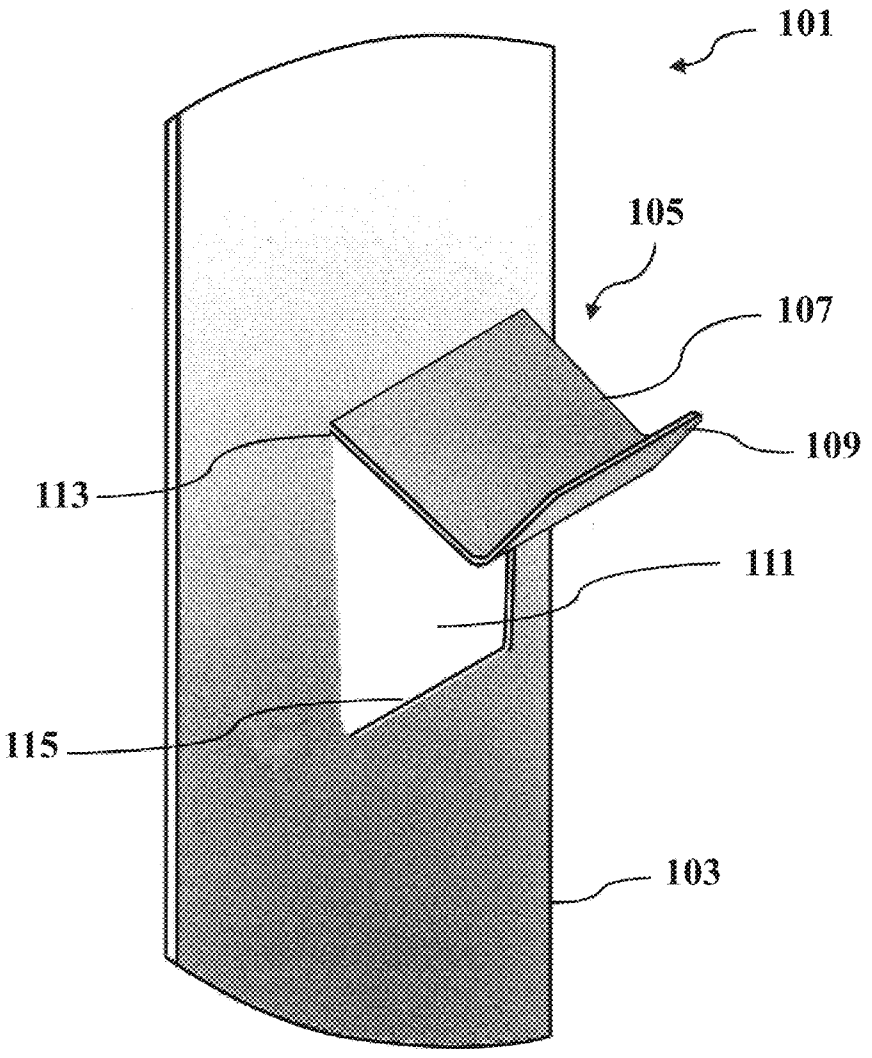
(57) **ABSTRACT**

Embodiments of a panel for use in building a tilt-wall building are disclosed, some of which comprise a plurality of structural studs, each comprising: a baseplate; an exterior-facing sidewall and an interior-facing sidewall connected by the baseplate; and a tab punched out of each of the sidewalls; an exterior concrete surface in which the tabs punched out of the exterior-facing sidewalls are embedded; and an interior concrete surface in which the tabs punched out of the interior-facing sidewalls are embedded; where the exterior and interior concrete surfaces are substantially planar surfaces that are substantially parallel to each other. Methods for forming tilt-wall panels are also disclosed.



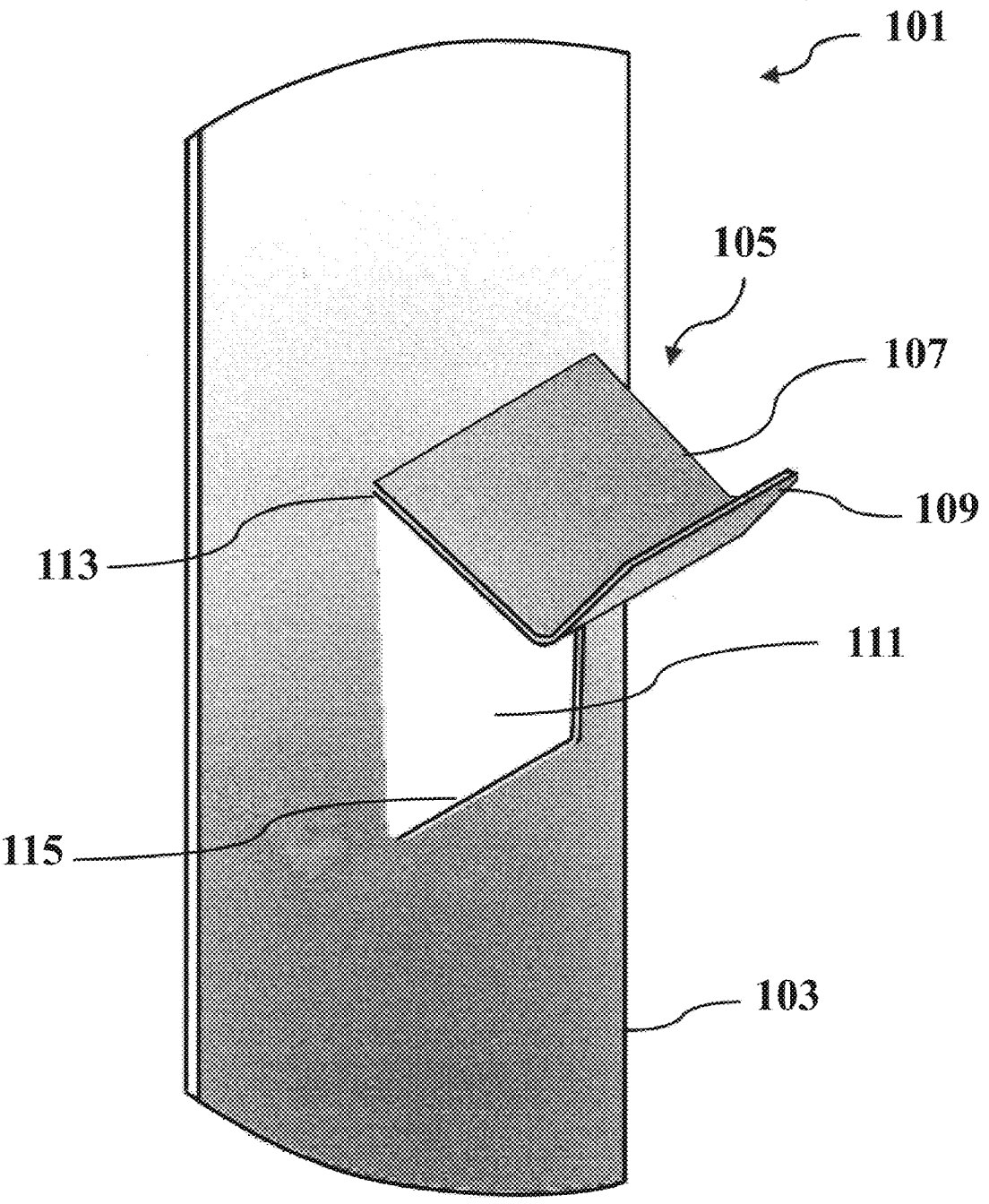


FIG. 1

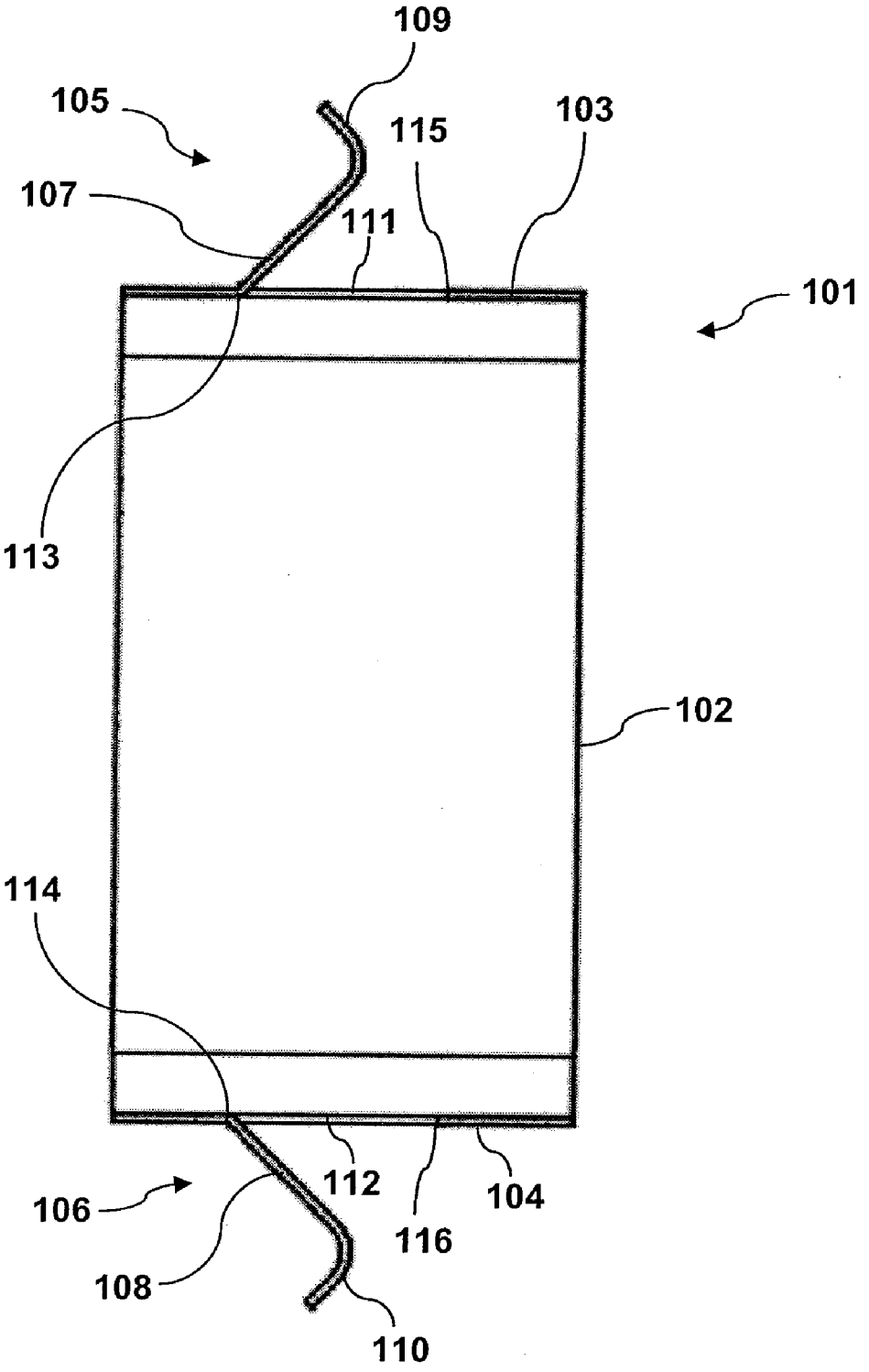


FIG. 2

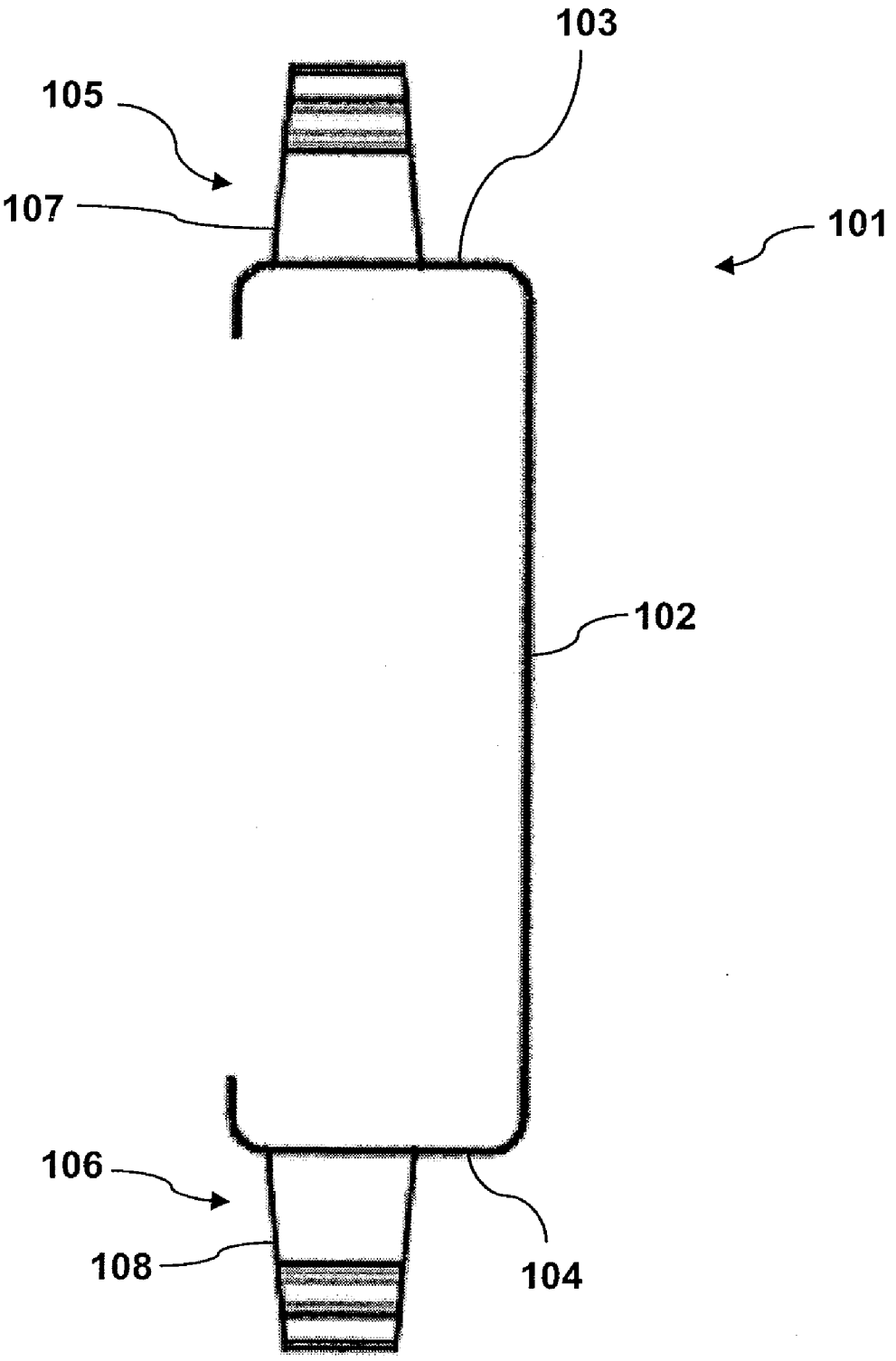


FIG. 3

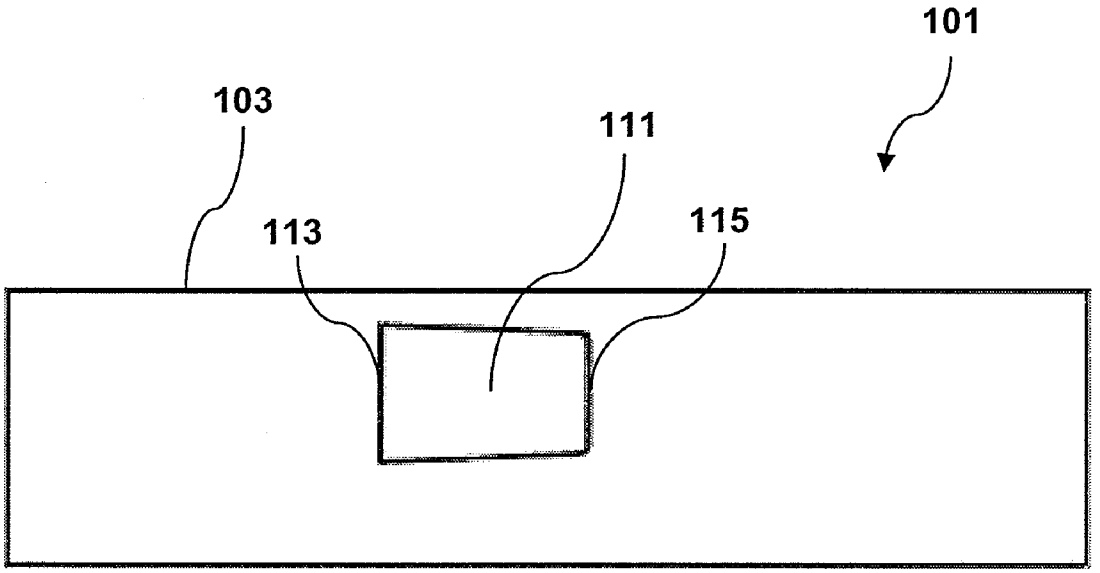


FIG. 4

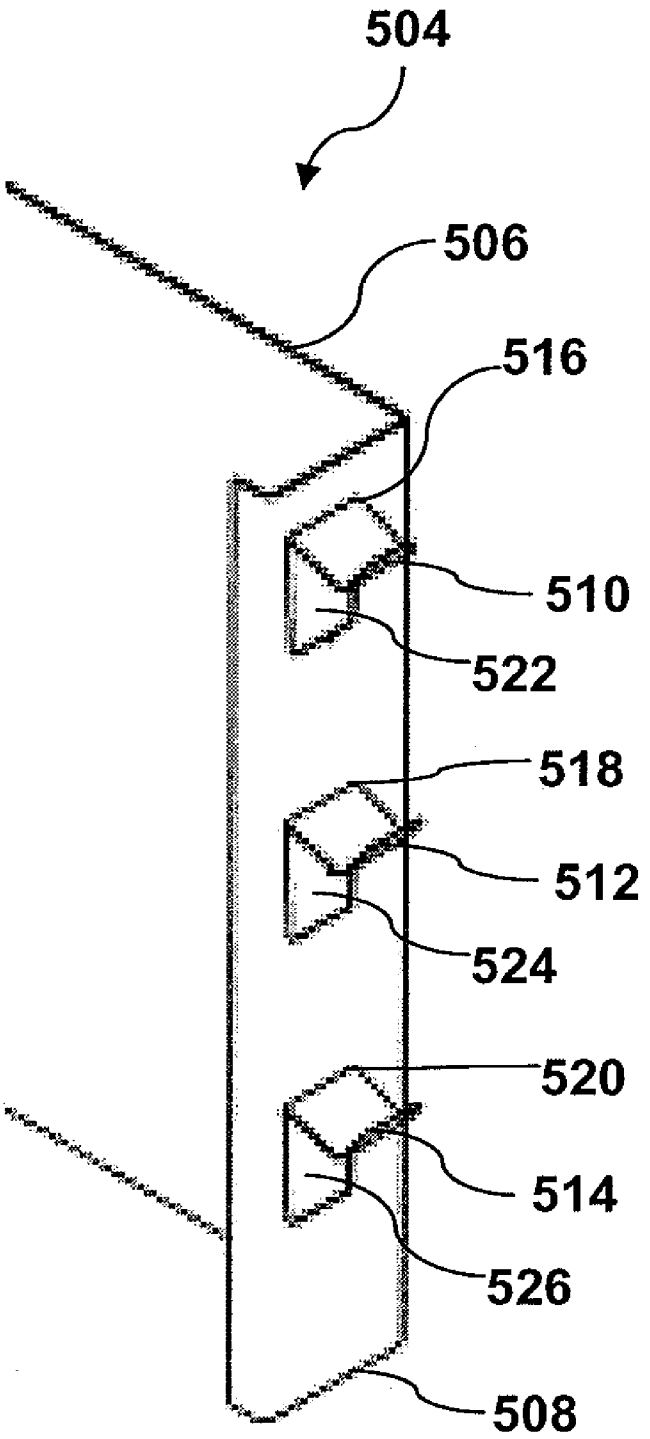


FIG. 5

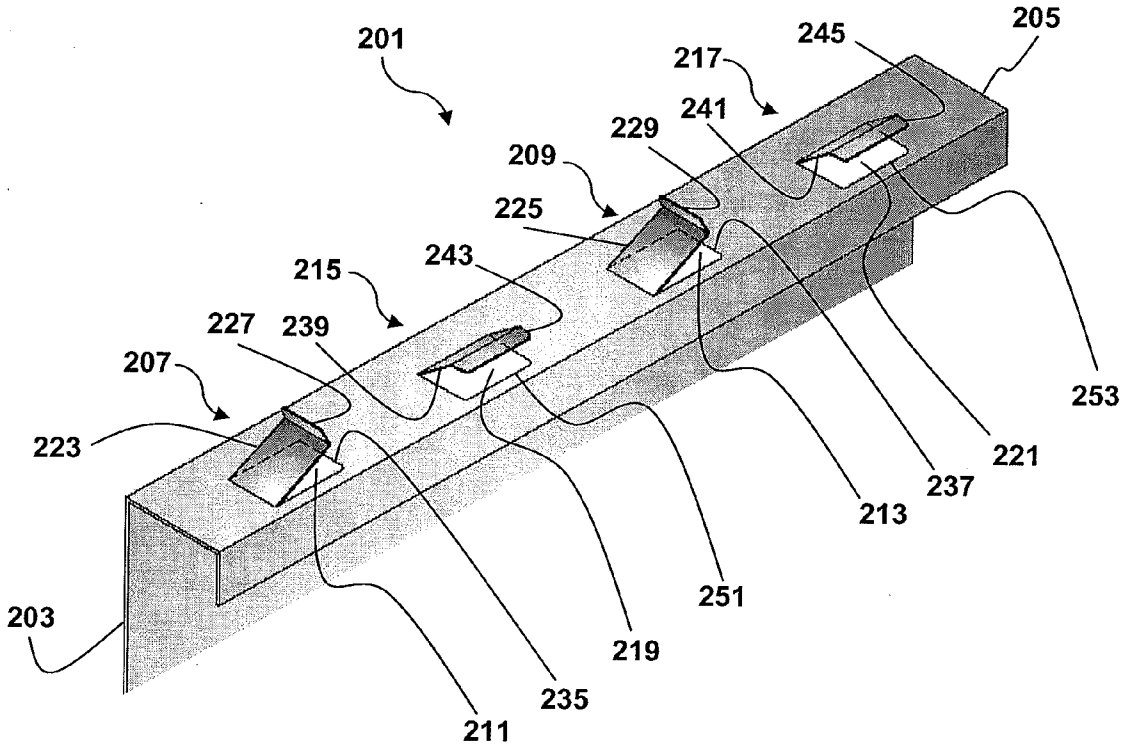

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FIG. 6

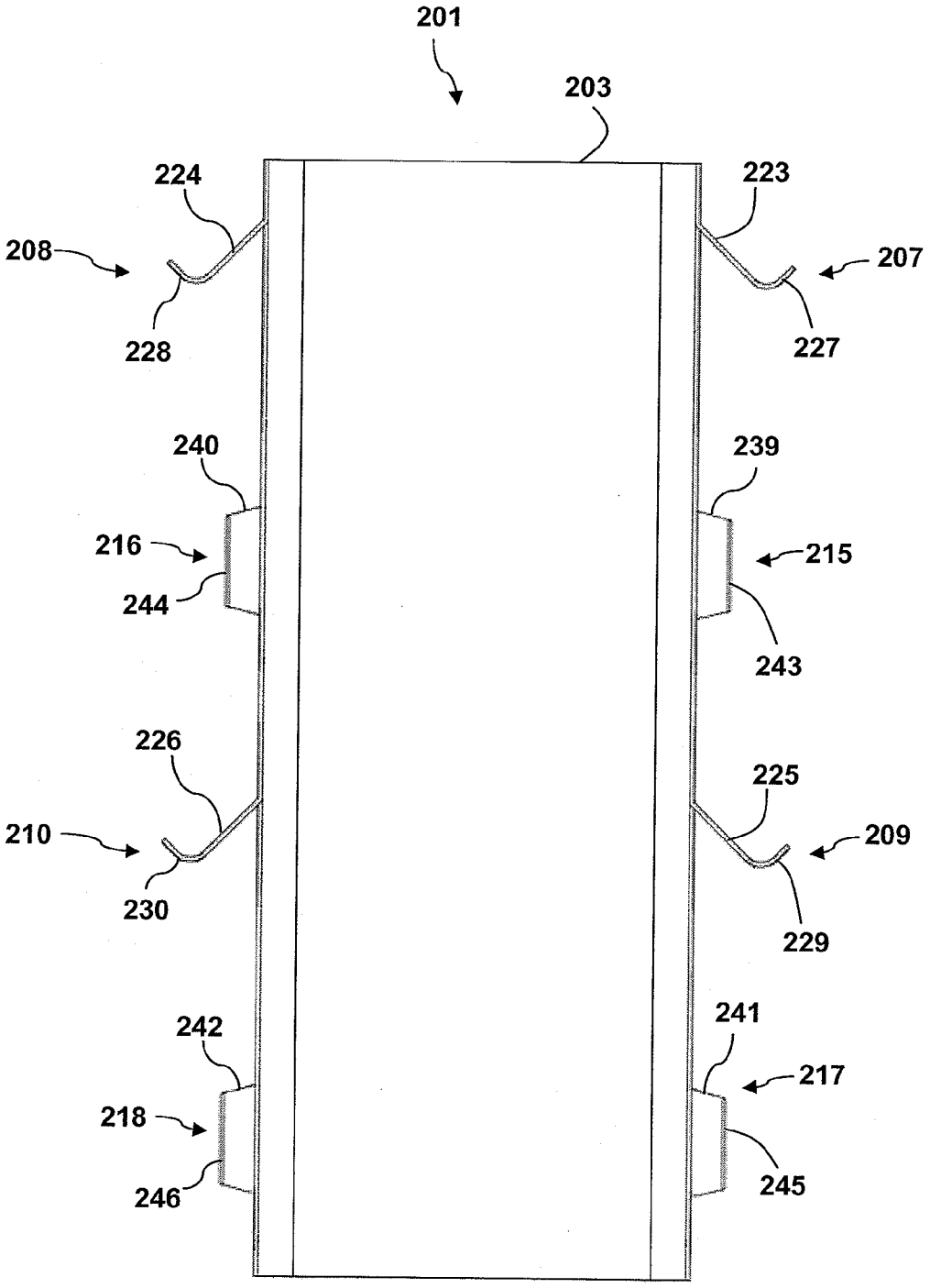
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FIG. 7

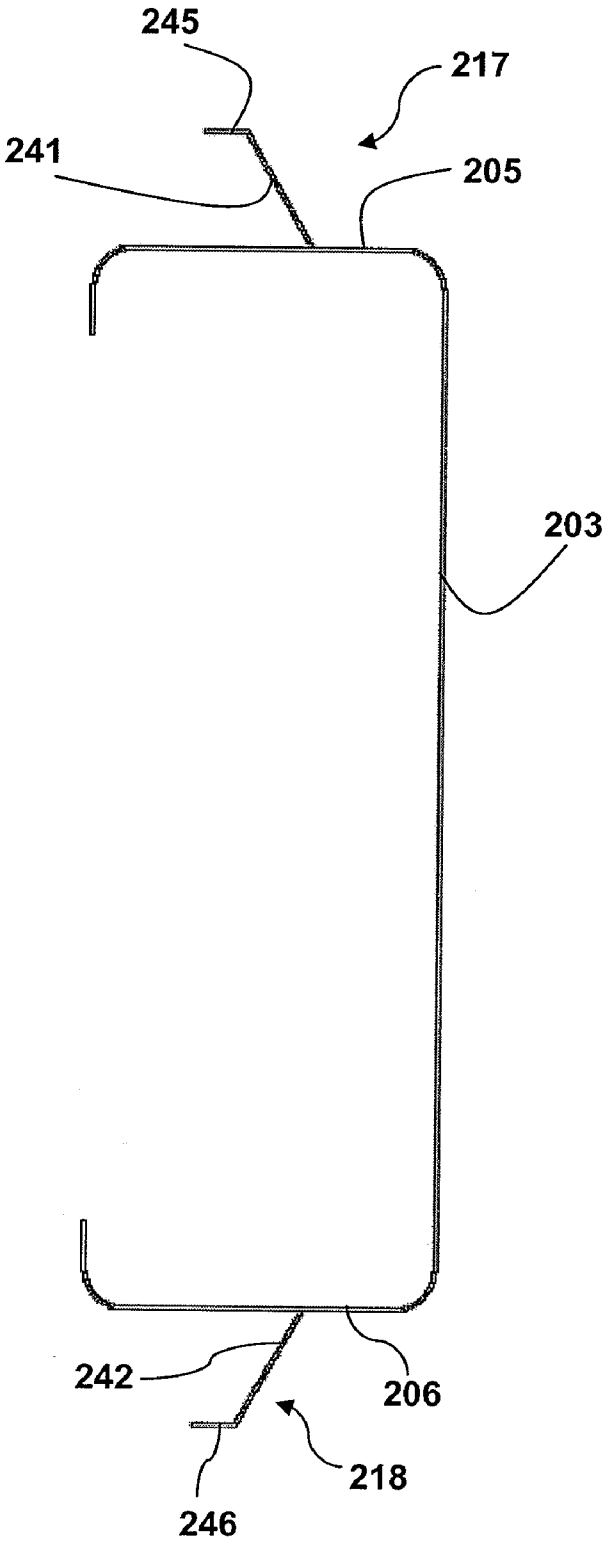

FIG. 8

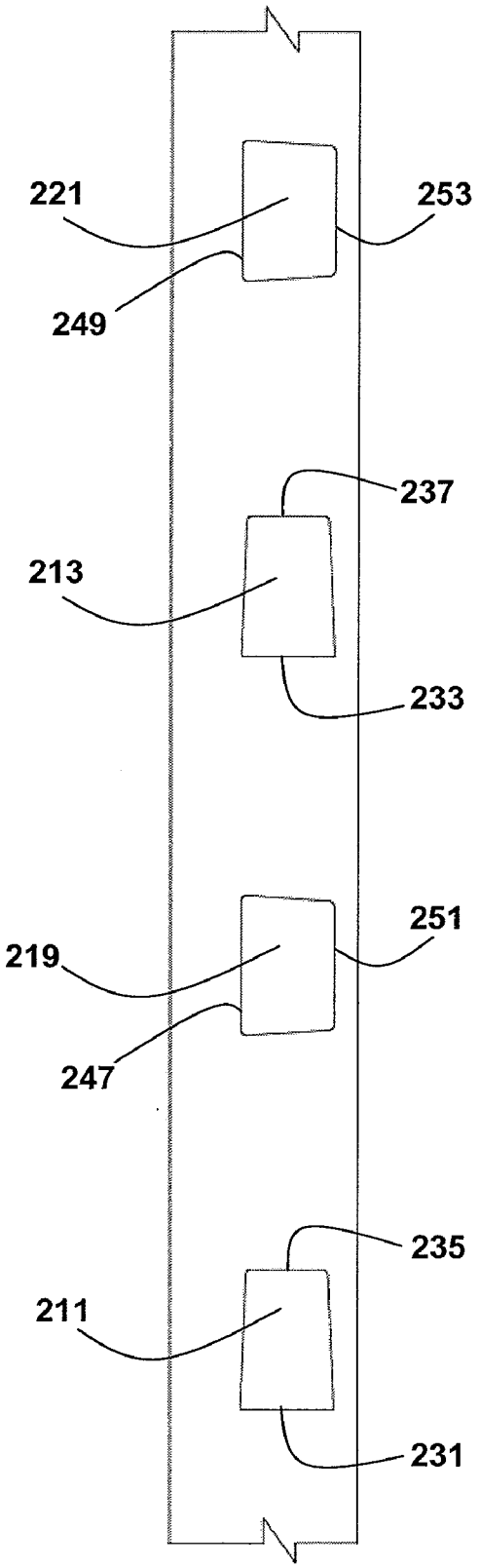

FIG. 9

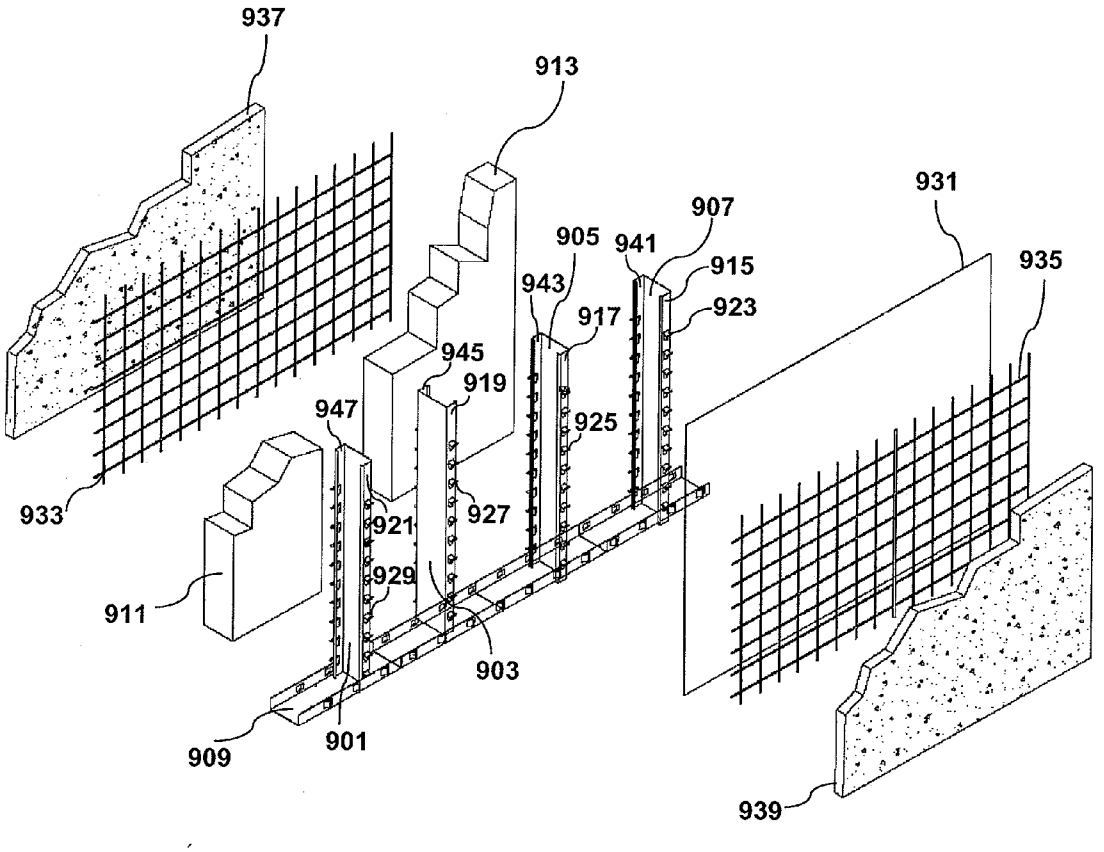
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FIG. 10

TILT-WALL PANEL

CROSS-REFERENCE(S) TO RELATED APPLICATION(S)

[0001] This application claims priority to U.S. Provisional Patent Application Ser. No. 61/080,632 filed Jul. 14, 2008, the entire contents of which are hereby incorporated by reference.

BACKGROUND OF THE INVENTION

[0002] 1. Field of the Invention

[0003] The present invention generally relates to the field of building construction. More particularly, the present invention relates to devices and methods for building a tilt-wall building.

[0004] 2. Related Art

[0005] The building and construction industry has previously employed a technique for forming walls in which structural studs are embedded in concrete to form tilt-wall panels, which are then lifted into place to form the walls of tilt-wall buildings. A primary challenge in creating tilt-wall panels is to embed the studs in concrete in such a way as to minimize or eliminate any separation between the studs and the concrete once the panel is formed and lifted into place. One means of addressing this challenge has been through the design of the structural studs themselves.

[0006] U.S. Pat. No. 6,151,858 to Ruiz, et al. ("Ruiz") discloses an example of one such design for a structural stud. The stud disclosed in Ruiz has a number of tabs extending outwardly from the sidewalls of the stud, and each of the tabs is derived as a cut-out portion of the sidewall. The tabs are L-shaped and are folded out from the sidewall along a bend line that is generally at right angles to the longitudinal axis of the stud. One problem with the machinery needed to form the tabs in Ruiz is that two strikes are required to form the tabs: one strike to punch the tab out of the sidewall and another strike to form the L-shape in the tab.

[0007] U.S. Publication No. 2005/0055967 to Kariakin ("Kariakin") discloses an example of another design for a structural stud. Kariakin describes a number of problems with the design disclosed in Ruiz, including that the L-shaped tabs are difficult to punch out from the sidewall of the stud due to the extreme right angle required which joins the two legs of the L-shape together. Kariakin also discloses that another problem with the L-shaped tab design is that the surrounding concrete does not completely engage the tab surface area, particularly around the right angle joint. Kariakin attempts to overcome these problems by employing tabs that are substantially curved in side elevational view such that the tabs are half U-shaped. The tabs in Kariakin are said to be formed by means of a rolling guide with a punch that pierces a portion of the sidewall in order to force the section outward to define the tab.

[0008] U.S. Publication No. 2007/0245657 to Valle, et al. ("Valle"), the contents of which are incorporated herein by reference in their entirety, discloses a structural stud that (1) provides improved adhesion between the stud and the surrounding concrete such that separation between the stud and the concrete is further minimized in comparison to the examples disclosed above and elsewhere in the prior art, and (2) can be formed by a device and a process that is less expensive and has less problems than the devices and processes by which other studs are formed. In certain embodiments, the structural stud of Valle comprises a stud having a sidewall and a tab punched out of the sidewall, the tab comprising: a tab leg that is substantially planar and is connected to the sidewall at one end of the tab leg, and that projects outwardly from the sidewall at an angle of less than ninety degrees to the sidewall; and a tab foot extending from the tab leg and curving either away from or toward a hole in the sidewall created by the tab punched out of the sidewall.

[0009] Tilt-wall building techniques have traditionally been used primarily for non-industrial buildings such as schools, office buildings, and retail stores. For such buildings, it is acceptable to form the tilt-wall panel in such a way that the side of the panel that serves as the exterior wall of the building is a uniform surface of concrete, while the interior side of the panel is open to reveal the structural studs used to form the panel. Leaving the interior side of the panel open allows for plumbing, electrical, and insulation materials to be installed inside the wall before traditional interior wall materials such as sheetrock and drywall are applied to the interior side of the panel to create a uniform interior wall surface.

[0010] Conventional tilt-wall building techniques have found less application for industrial buildings such as warehouses and manufacturing facilities. Industrial buildings often require a more rugged interior wall surface than is provided by sheetrock and drywall, due to collisions that can occur between heavy machinery (such as forklifts) and the interior wall surface. To provide a rugged interior wall surface, some in the industry have attempted to create tilt-wall panels having a concrete interior surface that is similar to the concrete exterior surface found on traditional tilt-wall panels. To create such panels, three to four inches of concrete are required for each of the interior and exterior surfaces in order to give the panel sufficient rigidity and structural integrity to withstand the tilt-wall lifting process and other forces imposed on the panel after it is lifted into place, and a number of pins are used to attach the interior surface concrete to the exterior surface concrete. In between the two concrete layers are two layers of re-bar (one for the interior surface concrete and one for the exterior surface concrete) and a two-inch layer of rigid board insulation. Such insulation is expensive compared to other types of insulation, but it is necessary to offset the high thickness and weight of the three to four inch concrete layers used for the interior and exterior surfaces.

[0011] What is needed is a tilt-wall panel for use in industrial buildings that provides a concrete interior surface and yet is lighter in weight, easier and less expensive to make, better insulated, and better suited to being used in the taller walls of industrial buildings than prior tilt-wall panels providing a concrete interior surface, and that has the benefit of improved adhesion between the studs used in the tilt-wall panel and the surrounding concrete.

[0012] The referenced shortcomings are not intended to be exhaustive, but rather are among many that tend to impair the effectiveness of previously known techniques for designing structural studs and tilt-wall panels; however, those mentioned here are sufficient to demonstrate that the methodologies appearing in the art have not been altogether satisfactory and that a significant need exists for the techniques described and claimed in this disclosure.

SUMMARY

[0013] Embodiments of the present invention include an improved tilt-wall panel that provides a concrete interior surface and yet is lighter in weight, easier and less expensive to

make, better insulated, and better suited to being used in the taller walls of industrial buildings than prior tilt-wall panels providing a concrete interior surface. A further benefit of the tilt-wall panels of certain embodiments of the present invention is that the structural studs used therein have the benefit of improved adhesion between the studs and the surrounding concrete.

[0014] In certain embodiments, the tilt-wall panel of the present invention comprises: a plurality of structural studs, each comprising: a baseplate; an exterior-facing sidewall and an interior-facing sidewall connected by the baseplate; and a tab punched out of each of the sidewalls, each tab comprising: a tab leg that is substantially planar and is connected to the sidewall at one end of the tab leg, and that projects outwardly from the sidewall at an angle of less than ninety degrees to the sidewall; and a tab foot extending from the tab leg and curving either away from or toward a hole in the sidewall created by the tab punched out of the sidewall; where the structural studs are arranged such that their baseplates are substantially parallel to each other and voids are formed between successive structural studs; an exterior concrete surface in which the tabs punched out of the exterior-facing sidewalls are embedded; and an interior concrete surface in which the tabs punched out of the interior-facing sidewalls are embedded; where the exterior and interior concrete surfaces are substantially planar surfaces that are substantially parallel to each other.

[0015] In some embodiments, one or more of the holes is defined by a base side and a top side, the base side has a greater length than the top side, and the tab leg extends from the base side. In other embodiments, one or more of the structural studs comprises a plurality of tabs. In one embodiment, the plurality of tabs is spaced such that the gap between successive tab leg connections to the sidewall is less than about six inches. In another embodiment, the gap between successive tab leg connections to the sidewall is about four inches.

[0016] In certain embodiments, the tilt-wall panel further comprises an insulation material in the voids formed between the structural studs. In other embodiments, the tilt-wall panel further comprises a rubberized insulation material applied to the tabs punched out of the exterior-facing sidewalls of the structural studs before the tabs were embedded in concrete. In still other embodiments, the tilt-wall panel further comprises a radiant barrier wrapped over the tabs punched out of the exterior-facing sidewalls of the structural studs before the tabs were embedded in concrete. In yet another embodiment, the tilt-wall panel further comprises wire mesh laid over both sidewalls of the structural studs before the tabs punched out of the sidewalls were embedded in concrete. In other embodiments, the tilt-wall panel further comprises lifting anchors and/or support anchors laid in the voids formed between the structural studs prior to embedding the tabs in concrete, such that a portion of each lifting anchor and/or support anchor is exposed in one or both of the concrete surfaces.

[0017] In certain embodiments, the present invention comprises a method of building a tilt-wall panel, comprising: obtaining a plurality of structural studs, each stud comprising: a baseplate; an exterior-facing sidewall and an interior-facing sidewall connected by the baseplate; and a tab punched out of each of the sidewalls, each tab comprising: a tab leg that is substantially planar and is connected to the sidewall at one end of the tab leg, and that projects outwardly from the sidewall at an angle of less than ninety degrees to the sidewall; and a tab foot extending from the tab leg and curving either away from or toward a hole in the sidewall created by the tab punched out of the sidewall; arranging the structural studs such that their baseplates are substantially parallel to each other and voids are formed between successive structural studs; forming an exterior concrete surface in which the tabs punched out of the exterior-facing sidewalls are embedded; and forming an interior concrete surface in which the tabs punched out of the interior-facing sidewalls are embedded; where the exterior and interior concrete surfaces are substantially planar surfaces that are substantially parallel to each other.

[0018] In some embodiments, the method further comprises laying lifting anchors and/or support anchors in the voids formed between the structural studs prior to embedding the tabs in concrete, such that a portion of each lifting anchor and/or support anchor is exposed once the concrete surfaces are formed. In other embodiments, the method further comprises placing an insulation material in the voids formed between the structural studs. In still other embodiments, the method further comprises applying a rubberized insulation material o the tabs punched out of the exterior-facing sidewalls of the structural studs prior to embedding the tabs in concrete. In yet another embodiment, the method further comprises, wrapping a radiant barrier over the tabs punched out of the exterior-facing sidewalls of the structural studs prior to embedding the tabs in concrete. In other embodiments, the method further comprises laying wire mesh over both sidewalls of the structural studs prior to embedding the tabs punched out of the sidewalls in concrete.

[0019] In certain embodiments, the tilt-wall panel of the present invention comprises a plurality of structural studs, each comprising: a baseplate; an exterior-facing sidewall and an interior-facing sidewall connected by the baseplate; a vertical tab punched out of each of the sidewalls and a vertical hole resulting from the vertical tab, the tab comprising: a tab leg that is substantially planar and is connected to the sidewall at one end of the tab leg, and that projects outwardly from the sidewall at an angle of less than ninety degrees to the sidewall; and a tab foot extending from the tab leg of the vertical tab punched out of the sidewall and curving either away from or toward the vertical hole in the sidewall resulting from the vertical tab punched out of the sidewall; and a horizontal tab punched out of each of the sidewalls and a horizontal hole resulting from the horizontal tab, the tab comprising: a tab leg that is substantially planar and is connected to the sidewall at one end of the tab leg, and that projects outwardly from the sidewall at an angle of less than ninety degrees to the sidewall; and a tab foot extending from the tab leg of the horizontal tab punched out of the sidewall and curving either away from or toward the horizontal hole in the sidewall resulting from the horizontal tab punched out of the sidewall; where the end of vertical tab leg that is connected to the sidewall is substantially perpendicular to the end of the horizontal tab leg that is connected to the sidewall; and where the structural studs are arranged such that their baseplates are substantially parallel to each other and voids are formed between successive structural studs; an exterior concrete surface in which the tabs punched out of the exterior-facing sidewalls are embedded; and an interior concrete surface in which the tabs punched out of the interior-facing sidewalls are embedded; where the exterior and interior concrete surfaces are substantially planar surfaces that are substantially parallel to each other.

[0020] In some embodiments, one or more of the vertical holes is defined by a base side and a top side, the base side has

a greater length than the top side, and the vertical tab leg the extends from the base side; and one or more of the horizontal holes is defined by a base side and a top side, the base side has a greater length than the top side, and the horizontal tab leg the extends from the base side. In other embodiments, one or more of the structural studs comprises a plurality of vertical tabs and resulting vertical holes and horizontal tabs and resulting horizontal holes. In still other embodiments, the vertical tabs and vertical holes and the horizontal tabs and horizontal holes are positioned in an alternating arrangement on the sidewall such that there is a horizontal tab and horizontal hole between each vertical tab and vertical hole. In yet another embodiment, the horizontal holes and the vertical holes are spaced such that the distance between the centers of successive vertical and horizontal holes is less than about 6 inches, while in other embodiments, the horizontal holes and the vertical holes are spaced such that the distance between the centers of successive vertical and horizontal holes is about 4 inches.

[0021] The use of the term "or" in the claims is used to mean "and/or" unless explicitly indicated to refer to alternatives only or the alternatives are mutually exclusive, although the disclosure supports a definition that refers to only alternatives and "and/or."

[0022] Throughout this application, the terms "substantially" and "about" are defined as at least close to (and includes) a given value or state (preferably within 10% of, more preferably within 1% of, and most preferably within 0.1% of).

[0023] Following long-standing patent law, the words "a" and "an," when used in conjunction with the word "comprising" in the claims or specification, denotes one or more, unless specifically noted.

[0024] As used in this specification and claim(s), the words "comprising" (and any form of comprising, such as "comprise" and "comprises"), "having" (and any form of having, such as "have" and "has"), "including" (and any form of including, such as "includes" and "include") or "containing" (and any form of containing, such as "contains" and "contain") are inclusive or open-ended and do not exclude additional, unrecited elements or method steps. As a result, a tilt-wall panel, device, or method that "comprises," "has," "contains," or "includes" one or more elements possesses those one or more elements, but is not limited to possessing only those one or more elements or steps. Likewise, an element of a tilt-wall panel, device, or method that "comprises," "has," "contains," or "includes" one or more features possesses those one or more features, but is not limited to possessing only those one or more features. Furthermore, a structure that is configured in a certain way must be configured in at least that way, but also may be configured in a way or ways that are not specified.

[0025] Descriptions of well-known processing techniques, components, and equipment are omitted so as not to unnecessarily obscure the present methods and devices in unnecessary detail. Other objects, features and advantages of the present invention will become apparent from the following detailed description. It should be understood, however, that the detailed description and the specific examples, while indicating specific embodiments of the invention, are given by way of illustration only, as various changes and modifications within the spirit and scope of the invention will become apparent to those skilled in the art from this detailed description.

[0026] The claims are not to be interpreted as including means-plus- or step-plus-function limitations, unless such a limitation is explicitly recited in a given claim using the phrase(s) "means for" or "step for," respectively.

BRIEF DESCRIPTION OF THE DRAWINGS

[0027] The following drawings illustrate by way of example and not limitation. Identical reference numerals do not necessarily indicate an identical structure. Rather, the same reference numeral may be used to indicate a similar feature or a feature with similar functionality. Every feature of each embodiment is not always labeled in every figure in which that embodiment appears, in order to keep the embodiments clear. The drawings form part of the present specification and are included to further demonstrate certain aspects of the present invention. The invention may be better understood by reference to one or more of these drawings in combination with the description of illustrative embodiments presented herein:

[0028] FIG. **1** is a partial isometric view of one embodiment of the structural studs used in the present tilt-wall panels.

[0029] FIG. **2** is a partial side view of one embodiment of the structural studs used in the present tilt-wall panels.

[0030] FIG. **3** is a front view of one embodiment of the structural studs used in the present tilt-wall panels.

[0031] FIG. **4** is a partial top view of one embodiment of the structural studs used in the present tilt-wall panels.

[0032] FIG. **5** is a partial isometric view of another embodiment of the structural studs used in the present tilt-wall panels.

[0033] FIG. **6** is a partial isometric view of another embodiment of the structural studs used in the present tilt-wall panels.

[0034] FIG. **7** is a partial side view of another embodiment of the structural studs used in the present tilt-wall panels.

[0035] FIG. **8** is a front view of another embodiment of the structural studs used in the present tilt-wall panels.

[0036] FIG. **9** is a partial top view of another embodiment of the structural studs used in the present tilt-wall panels.

[0037] FIG. **10** is a partial cutaway exploded perspective view of one embodiment of the present tilt-wall panels.

DESCRIPTION OF ILLUSTRATIVE EMBODIMENTS

[0038] One embodiment of the structural studs used in the present tilt-wall panels is partially shown in FIGS. **1-4**. The structural stud comprises a stud **101** having a baseplate **102**, sidewalls **103** and **104** connected to the baseplate **102**, and tabs **105** and **106** punched out of the sidewalls. The tabs **105** and **106** comprise tab legs **107** and **108** that are substantially planar and are connected to the sidewalls **103** and **104** at one end of tab legs **107** and **108**. The tab legs **107** and **108** project outwardly from the sidewalls **103** and **104** at an angle of less than ninety degrees to the sidewalls **103** and **104**. Having the tab legs **107** and **108** project outwardly at an angle of less than ninety degrees results in improved adhesion between the structural stud and the surrounding concrete. The tabs **105** and **106** also comprise tab feet **109** and **110** extending from the tab legs **107** and **108** and curving away from holes **111** and **112** in the sidewalls **103** and **104** created by the tabs **105** and **106** punched out of the sidewalls **103** and **104**. Having the tab feet **109** and **110** curve away from the holes **111** and **112** in the sidewalls **103** and **104** further results in improved adhesion

between the structural stud and the surrounding concrete. Having the tab feet **109** and **110** curve toward from the holes **111** and **112** in the sidewalls **103** and **104** achieves a similar effect. In some embodiments, the holes **111** and **112** in the sidewalls **103** and **104** are defined by base sides **113** and **114** and top sides **115** and **116**, the base sides have a greater length than the top sides, and the tab legs **107** and **108** extend from the base sides **113** and **114**.

[0039] Another embodiment of the structural studs used in the present tilt-wall panels is partially shown in FIG. **5**. In this embodiment, the structural stud **504** comprises a baseplate **506**, a sidewall **508**, a plurality of tabs **510**, **512**, and **514** punched out of the sidewall **508**, and a plurality of holes **522**, **524**, and **526** created by the tabs **510**, **512**, and **514** punched out of the sidewall **508**. In some embodiments, the plurality of tabs **510**, **512**, and **514** is spaced such that the gaps between successive ones of tab leg connections **516**, **518**, and **520** are anywhere from about 1 to about 24 inches, including about 1.5, 2, 2.5, 3, 3.5, 4, 4.5, 5, 5.5, 6, 6.5, 7, 7.5, 8, 8.5, 9, 9.5, 10, 10.5, 11, 11.5, 12, 12.5, 13, 13.5, 14, 14.5, 15, 15.5, 16, 16.5, 17, 17.5, 18, 18.5, 19, 19.5, 20, 20.5, 21, 21.5, 22, 22.5, 23, and 23.5 inches, or any range derivable within these numbers. In some embodiments, the gaps between successive ones of tab leg connections **516**, **518**, and **520** are less than about six inches, which further results in improved adhesion between the structural stud and the surrounding concrete. In other embodiments the gaps between successive ones of tab leg connection **516**, **518**, and **520** are about four inches.

[0040] While FIG. **5** only depicts three tabs in one sidewall of the structural stud, the number of tabs, the sizes of the tabs, and the spacing of the tabs in each of the sidewalls of the stud can vary depending on the size, thickness, and tensile strength of the structural stud. For example, the embodiments described above where the gaps between successive tab leg connections are less than about six inches, and in particular about four inches, encompass a structural stud where the width of the baseplate **506** is about 6 inches, the width of the sidewall **508** is about 2 inches, and the stud is composed of steel that is 16 gauge in thickness and has a tensile strength of 50 ksi (i.e., kilo-pound per square inch). For studs of different sizes and/or steel thicknesses and tensile strengths, the sizes of the gaps can be proportionally scaled. Other steel thicknesses that are suitable for use in certain embodiments of the structural studs of the present invention include 8, 9, 10, 11, 12, 14, 18, and 20 gauge steel. Other steel tensile strengths that are suitable for use in certain embodiments of the structural studs of the present invention include 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, and 55 ksi, or any range derivable within these numbers.

[0041] With regard to the size and number of the tabs, in some embodiments, the size and number of the tabs is such that the total surface area of the sidewall divided by the total surface area of the holes created by the tabs results in a ratio of less than about 9.6. More particularly, the ratio is any of the following: 9.6, 9.5, 9.4, 9.3, 9.2, 9.1, 9.0, 8.9, 8.8, 8.7, 8.6, 8.5, 8.4, 8.3, 8.2, 8.1, 8.0, 7.9, 7.8, 7.7, 7.6, 7.5, 7.4, 7.3, 7.2, 7.1, 7.0, 6.9, 6.8, 6.7, 6.6, 6.5, 6.4, 6.3, 6.2, 6.1, 6.0, 5.9, 5.8, 5.7, 5.6, 5.5, 5.4, 5.3, 5.2, 5.1, 5.0, 4.9, 4.8, 4.7, 4.6, 4.5, 4.4, 4.3, 4.2, 4.1, 4.0, 3.5, 3.0, 2.5, 2.0, and 1.5, or any range derivable within these numbers.

[0042] In other embodiments, the size and number of tabs is such that the total surface area of the holes created by the tabs is greater than about 10% of the total surface area of the sidewall. More particularly, the total surface area of the holes created by the tabs is any of the following percentages of the total surface area of the sidewall: 10.1%, 10.2%, 10.3%, 10.4%, 10.5%, 10.6%, 10.7%, 10.8%, 10.9%, 11.0%, 11.1%, 11.2%, 11.3%, 11.4%, 11.5%, 11.6%, 11.7%, 11.8%, 11.9%, 12.0%, 12.1%, 12.2%, 12.3%, 12.4%, 12.5%, 12.6%, 12.7%, 12.8%, 12.9%, 13.0%, 13.1%, 13.2%, 13.3%, 13.4%, 13.5%, 13.6%, 13.7%, 13.8%, 13.9%, 14.0%, 14.1%, 14.2%, 14.3%, 14.4%, 14.5%, 14.6%, 14.7%, 14.8%, 14.9%, 15.0%, 15.1%, 15.2%, 15.3%, 15.4%, 15.5%, 15.6%, 15.7%, 15.8%, 15.9%, 16.0%, 17%, 18%, 19%, 20%, 25%, 30%, 35%, 40%, 45%, 50%, 55%, 60%, 65%, or 70%, or any range derivable within these numbers.

[0043] Another embodiment of the structural studs used in the present tilt-wall panels is partially shown in FIGS. **6-9**. In this embodiment, the structural stud **201** comprises a baseplate **203**, sidewalls **205** and **206**, a plurality of vertical tabs **207**, **208**, **209**, and **210** punched out of the sidewalls **205** and **206**, a plurality of vertical holes **211**, **212** (not shown), **213**, and **214** (not shown) created by the vertical tabs **207**, **208**, **209**, and **210** punched out of the sidewalls **205** and **206**, a plurality of horizontal tabs **215**, **216**, **217**, and **218** punched out of the sidewalls **205** and **206**, and a plurality of horizontal holes **219**, **220** (not shown), **221**, and **222** (not shown) created by the horizontal tabs **215**, **216**, **217**, and **218** punched out of the sidewalls **205** and **206**.

[0044] The vertical tabs **207**, **208**, **209**, and **210** comprise tab legs **223**, **224**, **225**, and **226** that are substantially planar and are connected to the sidewalls **205** and **206** at one end of the tab legs **223**, **224**, **225**, and **226**. The tab legs **223**, **224**, **225**, and **226** project outwardly from the sidewalls **205** and **206** at an angle of less than ninety degrees to the sidewalls **205** and **206**. Having the tab legs **223**, **224**, **225**, and **226** project outwardly at an angle of less than ninety degrees results in improved adhesion between the structural stud and the surrounding concrete. The vertical tabs **207**, **208**, **209**, and **210** also comprise tab feet **227**, **228**, **229**, and **230** extending from the tab legs **223**, **224**, **225**, and **226** and curving away from vertical holes **211**, **212** (not shown), **213**, and **214** (not shown) created by the vertical tabs **207**, **208**, **209**, and **210** punched out of the sidewalls **205** and **206**. Having the tab feet **227**, **228**, **229**, and **230** curve away from the vertical holes **211**, **212** (not shown), **213**, and **214** (not shown) in the sidewalls **205** and **206** further results in improved adhesion between the structural stud and the surrounding concrete. Having the tab feet **227**, **228**, **229**, and **230** curve toward from the holes **211**, **212** (not shown), **213**, and **214** (not shown) in the sidewalls **205** and **206** achieves a similar effect. In some embodiments, the vertical holes **211**, **212** (not shown), **213**, and **214** (not shown) in the sidewalls **205** and **206** are defined by base sides **231**, **232** (not shown), **233**, and **234** (not shown) and top sides **235**, **236** (not shown), **237**, and **238** (not shown), the base sides have a greater length than the top sides, and the tab legs **223**, **224**, **225**, and **226** extend from the base sides **231**, **232** (not shown), **233**, and **234** (not shown).

[0045] The horizontal tabs **215**, **216**, **217**, and **218** comprise tab legs **239**, **240**, **241**, and **242** that are substantially planar and are connected to the sidewalls **205** and **206** at one end of the tab legs **239**, **240**, **241**, and **242**. The tab legs **239**, **240**, **241**, and **242** project outwardly from the sidewalls **205** and **206** at an angle of less than ninety degrees to the sidewalls **205** and **206**. Having the tab legs **239**, **240**, **241**, and **242** project outwardly at an angle of less than ninety degrees results in improved adhesion between the structural stud and the surrounding concrete. The horizontal tabs **215**, **216**, **217**, and **218**

also comprise tab feet **243**, **244**, **245**, and **246** extending from the tab legs **239**, **240**, **241**, and **242** and curving toward horizontal holes **219**, **220** (not shown), **221**, and **222** (not shown) created by the horizontal tabs **215**, **216**, **217**, and **218** punched out of the sidewalls **205** and **206**. Having the tab feet **243**, **244**, **245**, and **246** curve toward the horizontal holes **219**, **220** (not shown), **221**, and **222** (not shown) in the sidewalls **205** and **206** further results in improved adhesion between the structural stud and the surrounding concrete. Having the tab feet **243**, **244**, **245**, and **246** curve away from the holes **219**, **220** (not shown), **221**, and **222** (not shown) in the sidewalls **205** and **206** achieves a similar effect. In some embodiments, the horizontal holes **219**, **220** (not shown), **221**, and **222** (not shown) in the sidewalls **205** and **206** are defined by base sides **247**, **248** (not shown), **249**, and **250** (not shown) and top sides **251**, **252** (not shown), **253**, and **254** (not shown), the base sides have a greater length than the top sides, and the tab legs **239**, **240**, **241**, and **242** extend from the base sides **247**, **248** (not shown), **249**, and **250** (not shown).

[0046] In the embodiment shown in FIGS. **6-9**, base sides **247** and **249** and top sides **251** and **253** for horizontal holes **219** and **221** are substantially perpendicular to base sides **231** and **233** and top sides **235** and **237** for vertical holes **211** and **213**. Thus, the ends of vertical tab legs **223** and **225** connected to the sidewall **205** are substantially perpendicular to the ends of horizontal tab legs **239** and **241** connected to the sidewall **205**. This substantially perpendicular arrangement results in further improved adhesion between the structural stud and the surrounding concrete and makes panels that comprise the stud and concrete combination more resistant to shear stress, particularly the high shear stress that can occur in the taller walls that are often required for industrial buildings.

[0047] In the embodiment shown in FIGS. **6-9**, the vertical tabs **207** and **209** and vertical holes **211** and **213** and the horizontal tabs **215** and **217** and horizontal holes **219** and **221** are positioned in an alternating arrangement on sidewall **205** such that there is a horizontal tab and horizontal hole between each vertical tab and vertical hole. In some embodiments, the horizontal holes and the vertical holes are spaced such that the distance between the centers of successive vertical and horizontal holes is anywhere from about 1 to about 24 inches, including about 1.5, 2, 2.5, 3, 3.5, 4, 4.5, 5, 5.5, 6, 6.5, 7, 7.5, 8, 8.5, 9, 9.5, 10, 10.5, 11, 11.5, 12, 12.5, 13, 13.5, 14, 14.5, 15, 15.5, 16, 16.5, 17, 17.5, 18, 18.5, 19, 19.5, 20, 20.5, 21, 21.5, 22, 22.5, 23, and 23.5 inches, or any range derivable within these numbers. In some embodiments, the distance between the centers of successive vertical and horizontal holes is less than about 6 inches, which further results in improved adhesion between the structural stud and the surrounding concrete. In other embodiments the distance between the centers of successive vertical and horizontal holes is about four inches.

[0048] While FIGS. **6-9** only depict four tabs in each of the sidewalls of the structural stud, the number of tabs, the sizes of the tabs, and the spacing of the tabs can vary depending on the size, thickness, and tensile strength of the structural stud. For example, the embodiments described above where the distance between the centers of successive vertical and horizontal holes is less than about six inches, and in particular about four inches, encompass a structural stud where the width of the baseplate **203** is about 6 inches, the width of the sidewalls **205** and **206** is about 2 inches, and the stud is composed of steel that is 16 gauge in thickness and has a tensile strength of 50 ksi (i.e., kilo-pound per square inch). For studs of different sizes and/or steel thicknesses and tensile strengths, the distances between the holes can be proportionally scaled. Other steel thicknesses that are suitable for use in certain embodiments of the structural studs of the present invention include 8, 9, 10, 11, 12, 14, 18, and 20 gauge steel. Other steel tensile strengths that are suitable for use in certain embodiments of the structural studs of the present invention include 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, and 55 ksi, or any range derivable within these numbers.

[0049] A partial cutaway exploded view of one embodiment of the present tilt-wall panels is depicted in FIG. **10**. As shown in FIG. **10**, this embodiment comprises a plurality of vertical structural studs **901**, **903**, **905**, and **907**, which have a plurality of tabs punched in their respective sidewalls as described above regarding the studs depicted in FIGS. **1-5**. In this embodiment, the plurality of tabs punched in the sidewalls of the vertical studs are spaced such that the gaps between successive ones of the tab leg connections are from about four to about six inches. The vertical studs are arranged perpendicular to horizontal stud **909**, which has a plurality of tabs punched in both of its sidewalls as described above for the studs depicted in FIGS. **1-5**. In this embodiment, the panel further comprises a rigid insulation material **911** and **913** positioned in between each of the vertical studs. Examples of suitable rigid insulation material are prefabricated extruded Dow®-brand insulation products. In contrast to the expensive two-inch layer of rigid board insulation that is required in the prior insulated tilt-wall panels providing a concrete interior surface due to their excessive thickness and weight, any rigid insulation material can be used in the present panels as long as it is sturdy enough to withstand the weight of the concrete used in the panel. Thus, it is possible for panels according to some embodiments of the present invention to achieve twice the insulation of prior insulated tilt-wall panels providing a concrete interior surface at half the weight, which can lead to a reduction in the cost required to produce the insulated panels of over seventy-five percent.

[0050] To further improve the insulating characteristics of the panel, this embodiment further comprises (1) a rubberized insulation material applied to the tabs punched out of exterior-facing sidewalls **915**, **917**, **919**, and **921** of the vertical studs, which includes, by way of example, tabs **923**, **925**, **927**, and **929**, and (2) a radiant barrier **931** wrapped over the tabs of the exterior-facing sidewall of the vertical studs. In one embodiment, the radiant barrier comprises two sheets of foil and encapsulated air. This embodiment of the tilt-wall panels further comprises wire mesh **933** and **935** laid over both sidewalls of the vertical studs. Finally, concrete surfaces **937** and **939** are formed over the wire mesh layers to complete the panel, with the tabs punched out of interior-facing sidewalls **941**, **943**, **945**, and **947** embedded in interior concrete surface **937** and the tabs punched out of exterior-facing sidewalls **915**, **917**, **919**, and **921** embedded in exterior concrete surface **939**. In this embodiment, the concrete thickness for each of the concrete surfaces is about two inches, although other thicknesses can be achieved and used.

[0051] Once the panels of the present invention are formed, they can then be raised such that they are substantially perpendicular to the ground to form a wall or part of a wall. In some embodiments, the panels further comprise lifting anchors laid in the voids formed between the vertical studs **901**, **903**, **905**, and **907** prior to embedding the studs and wire mesh **933** and **935** in concrete to form the concrete surfaces

937 and **939**, such that a portion of each lifting anchor is exposed once the concrete surfaces **937** and **939** are formed. The lifting anchors can then be used to raise the panel such that it is substantially perpendicular to the ground. In other embodiments, the panels further comprise support anchors laid in the voids formed between the vertical studs **901**, **903**, **905**, and **907** prior to embedding the studs and wire mesh **933** and **935** in concrete to form the concrete surfaces **937** and **939**, such that a portion of each support anchor is exposed once the concrete surfaces **937** and **939** are formed. Supports can then attached to the support anchors. In some embodiments, anywhere from 1 to 36 lifting anchors and/or support anchors can be used to raise and/or support a panel, including 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, and 36 lifting anchors and/or support anchors, or any range derivable within these numbers. Those of skill in the art can determine the appropriate number of lifting anchors and/or support anchors, placement of the lifting anchors and/or support anchors, and manner of attaching the lifting anchors to the lifting apparatus and/or the support anchors to the support apparatus for a given panel size to safely and efficiently raise a panel into position and/or support the panel once it is raised into position without having the panel break under its own weight during the lifting and/or supporting process.

[0052] While FIG. **10** only depicts four vertical studs in the tilt-wall panel, each having ten vertical tabs punched at four- to six-inch spacing in each sidewall, the number of studs, the number of tabs, the sizes of the tabs, the spacing of the tabs, and the orientation of the tabs can vary depending on the size, thickness, and tensile strength of the structural stud, as discussed previously.

What is claimed is:

1. A tilt-wall panel comprising:

a plurality of structural studs, each comprising:

a baseplate;

an exterior-facing sidewall and an interior-facing sidewall connected by the baseplate; and

a tab punched out of each of the sidewalls, each tab comprising:

a tab leg that is substantially planar and is connected to the sidewall at one end of the tab leg, and that projects outwardly from the sidewall at an angle of less than ninety degrees to the sidewall; and

a tab foot extending from the tab leg and curving either away from or toward a hole in the sidewall created by the tab punched out of the sidewall;

where the structural studs are arranged such that their baseplates are substantially parallel to each other and voids are formed between successive structural studs;

an exterior concrete surface in which the tabs punched out of the exterior-facing sidewalls are embedded; and

an interior concrete surface in which the tabs punched out of the interior-facing sidewalls are embedded;

where the exterior and interior concrete surfaces are substantially planar surfaces that are substantially parallel to each other.

2. The tilt-wall panel of claim **1**, where one or more of the holes is defined by a base side and a top side, the base side has a greater length than the top side, and the tab leg extends from the base side.

3. The tilt-wall panel of claim **1**, where one or more of the structural studs comprises a plurality of tabs.

4. The tilt-wall panel of claim **3**, where the plurality of tabs is spaced such that the gap between successive tab leg connections to the sidewall is less than about six inches.

5. The tilt-wall panel of claim **4**, where the gap between successive tab leg connections to the sidewall is about four inches.

6. The tilt-wall panel of claim **1**, further comprising an insulation material in the voids formed between the structural studs.

7. The tilt-wall panel of claim **1**, further comprising a rubberized insulation material applied to the tabs punched out of the exterior-facing sidewalls of the structural studs before the tabs were embedded in concrete.

8. The tilt-wall panel of claim **1**, further comprising a radiant barrier wrapped over the tabs punched out of the exterior-facing sidewalls of the structural studs before the tabs were embedded in concrete.

9. The tilt-wall panel of claim **1**, further comprising wire mesh laid over both sidewalls of the structural studs before the tabs punched out of the sidewalls were embedded in concrete.

10. The tilt-wall panel of claim **1**, further comprising lifting anchors laid in the voids formed between the structural studs prior to embedding the tabs in concrete, such that a portion of each lifting anchor is exposed in one or both of the concrete surfaces.

11. The tilt-wall panel of claim **1**, further comprising support anchors laid in the voids formed between the structural studs prior to embedding the tabs in concrete, such that a portion of each support anchor is exposed in one or both of the concrete surfaces.

12. A method of building a tilt-wall panel, comprising:

obtaining a plurality of structural studs, each stud comprising:

a baseplate;

an exterior-facing sidewall and an interior-facing sidewall connected by the baseplate; and

a tab punched out of each of the sidewalls, each tab comprising:

a tab leg that is substantially planar and is connected to the sidewall at one end of the tab leg, and that projects outwardly from the sidewall at an angle of less than ninety degrees to the sidewall; and

a tab foot extending from the tab leg and curving either away from or toward a hole in the sidewall created by the tab punched out of the sidewall;

arranging the structural studs such that their baseplates are substantially parallel to each other and voids are formed between successive structural studs;

forming an exterior concrete surface in which the tabs punched out of the exterior-facing sidewalls are embedded; and

forming an interior concrete surface in which the tabs punched out of the interior-facing sidewalls are embedded;

where the exterior and interior concrete surfaces are substantially planar surfaces that are substantially parallel to each other.

13. The method of claim **12**, further comprising:

laying lifting anchors in the voids formed between the structural studs prior to embedding the tabs in concrete, such that a portion of each lifting anchor is exposed once the concrete surfaces are formed.

14. The method of claim **12**, further comprising:
laying support anchors in the voids formed between the structural studs prior to embedding the tabs in concrete, such that a portion of each support anchor is exposed once the concrete surfaces are formed.

15. The method of claim **12**, further comprising placing an insulation material in the voids formed between the structural studs.

16. The method of claim **12**, further comprising applying a rubberized insulation material to the tabs punched out of the exterior-facing sidewalls of the structural studs prior to embedding the tabs in concrete.

17. The method of claim **12**, further comprising wrapping a radiant barrier over the tabs punched out of the exterior-facing sidewalls of the structural studs prior to embedding the tabs in concrete.

18. The method of claim **12**, further comprising laying wire mesh over both sidewalls of the structural studs prior to embedding the tabs punched out of the sidewalls in concrete.

19. A tilt-wall panel comprising:
a plurality of structural studs, each comprising:
a baseplate;
an exterior-facing sidewall and an interior-facing sidewall connected by the baseplate;
a vertical tab punched out of each of the sidewalls and a vertical hole resulting from the vertical tab, the tab comprising:
a tab leg that is substantially planar and is connected to the sidewall at one end of the tab leg, and that projects outwardly from the sidewall at an angle of less than ninety degrees to the sidewall; and
a tab foot extending from the tab leg of the vertical tab punched out of the sidewall and curving either away from or toward the vertical hole in the sidewall resulting from the vertical tab punched out of the sidewall; and
a horizontal tab punched out of each of the sidewalls and a horizontal hole resulting from the horizontal tab, the tab comprising:
a tab leg that is substantially planar and is connected to the sidewall at one end of the tab leg, and that projects outwardly from the sidewall at an angle of less than ninety degrees to the sidewall; and
a tab foot extending from the tab leg of the horizontal tab punched out of the sidewall and curving either away from or toward the horizontal hole in the sidewall resulting from the horizontal tab punched out of the sidewall;
where the end of vertical tab leg that is connected to the sidewall is substantially perpendicular to the end of the horizontal tab leg that is connected to the sidewall; and
where the structural studs are arranged such that their baseplates are substantially parallel to each other and voids are formed between successive structural studs;
an exterior concrete surface in which the tabs punched out of the exterior-facing sidewalls are embedded; and
an interior concrete surface in which the tabs punched out of the interior-facing sidewalls are embedded;
where the exterior and interior concrete surfaces are substantially planar surfaces that are substantially parallel to each other.

20. The tilt-wall panel of claim **19**, where:
one or more of the vertical holes is defined by a base side and a top side, the base side has a greater length than the top side, and the vertical tab leg the extends from the base side; and
one or more of the horizontal holes is defined by a base side and a top side, the base side has a greater length than the top side, and the horizontal tab leg the extends from the base side.

21. The tilt-wall panel claim **19**, where one or more of the structural studs comprises a plurality of vertical tabs and resulting vertical holes and horizontal tabs and resulting horizontal holes.

22. The tilt-wall panel of claim **21**, where the vertical tabs and vertical holes and the horizontal tabs and horizontal holes are positioned in an alternating arrangement on the sidewall such that there is a horizontal tab and horizontal hole between each vertical tab and vertical hole.

23. The tilt-wall panel of claim **22**, where the horizontal holes and the vertical holes are spaced such that the distance between the centers of successive vertical and horizontal holes is less than about 6 inches.

24. The tilt-wall panel of claim **23**, where the horizontal holes and the vertical holes are spaced such that the distance between the centers of successive vertical and horizontal holes is about 4 inches.

25. The tilt-wall panel of claim **19**, further comprising an insulation material in the voids formed between the structural studs.

26. The tilt-wall panel of claim **19**, further comprising a rubberized insulation material applied to the tabs punched out of the exterior-facing sidewalls of the structural studs before the tabs were embedded in concrete.

27. The tilt-wall panel of claim **19**, further comprising a radiant barrier wrapped over the tabs punched out of the exterior-facing sidewalls of the structural studs before the tabs were embedded in concrete.

28. The tilt-wall panel of claim **19**, further comprising wire mesh laid over both sidewalls of the structural studs before the tabs punched out of the sidewalls were embedded in concrete.

29. The tilt-wall panel of claim **19**, further comprising lifting anchors laid in the voids formed between the structural studs prior to embedding the tabs in concrete, such that a portion of each lifting anchor is exposed in one or both of the concrete surfaces.

30. The tilt-wall panel of claim **19**, further comprising support anchors laid in the voids formed between the structural studs prior to embedding the tabs in concrete, such that a portion of each support anchor is exposed in one or both of the concrete surfaces.

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