A light gage shear panels used in multistory building construction where it is desirable to have the load bearing walls of successive floors stacked directly on top of each other and structurally connected thereto. Methods of on-site building construction using prefabricated shear panels are disclosed.
MODULAR SHEAR PANEL FOR LIGHT GAGE STEEL CONSTRUCTION OF MULTISTORY BUILDINGS AND METHOD OF CONSTRUCTION

BACKGROUND OF THE INVENTION

[0001] The present invention relates generally to light gage shear panels used in multistory building construction.

[0002] In many applications for many years, buildings have been constructed of wooden 2×4’s nailed together at the building site to form the vertical walls of the building. More recently, the wood used in this traditional “stick built” construction or “framing” has been replaced with light gage steel framing members.

[0003] “Light gage” as used in this application is cold rolled steel between about 10 gage (0.12" in thickness) to about 25 gage (0.15" in thickness). Usually, wide rolls of steel are slit and formed or shaped by rolling mills or presses into the individual generally C-shaped structural members that replace the wood studs. These structural members may be assembled with the aid of sheet metal screws at the construction site.

[0004] One of the disadvantages of light gage construction as compared with wood is the resistance of compressive loads due to the thinness thereof. This is particularly important for lateral loads such as imparted by wind and/or seismic events and it is a practice to insert shear panels into the walls at spaced intervals.

[0005] Cables have been used to connect the vertical truss members of some shear panels. These cables are designed to provide resistance in tension in both lateral directions. However, in practice, like the stays for the mast of a sailing vessel, these cables are effective in only one lateral direction at any one time, i.e. the stays on the windward side are under tension and slack on the leeward side. In the event of a sudden change in wind direction, or the back and forth movement of a building subject to a seismic event, there is a period of time when the cables on one side have released and the cables on the other side has not yet engaged.

[0006] In one aspect, the present invention improves the shear resistance of shear panels through the use of web members constructed to have lateral resistance to both tension and compression.

[0007] In the construction of multistory buildings such as apartments, it is highly desirable to have the load bearing walls of successive floors stacked directly on top of each other. Such buildings are constructed one floor at a time, i.e., the walls of a lower floor are erected and the floor of the upper floor installed on them before the walls of the upper floor are erected. The alignment of a wall on an upper floor directly over the wall of the immediately lower floor has proven to be problematic once the floor is in place. In another aspect, the present invention facilitates the alignment of walls on successive floors.

[0008] In addition to wall alignment, it is desirable for the walls of the building on different floors to be directly connected to each other, particularly in seismic zones. Thus, a connection is desirable from the wall on each lower floor to the wall on the floor above. In another aspect, the present invention facilitates such connections.

[0009] The shear panels of the present invention may also be prefabricated for shipment to the construction site reducing the labor needs at the construction site and improving the efficiency and quality of construction. The panels are of size and weight manageable on site where they may be used with other light gage steel building components in the construction of the building using conventional techniques and tools.

[0010] These and many other objects and advantages of the present invention will be readily apparent to one skilled in the art to which the invention pertains from a perusal of the claims, the appended drawings, and the following detailed description of the preferred embodiments.

BRIEF DESCRIPTION OF THE DRAWINGS

[0011] FIG. 1 is a front view in elevation of one embodiment of the shear panel of the present invention.

[0012] FIG. 2 is a front view in elevation of one embodiment of a base plate to which the shear panel of FIG. 1 may be mounted.

[0013] FIG. 3 is a pictorial view illustrating the assembly of the panel of FIG. 1 into the base plate of FIG. 2.

[0014] FIG. 4 is a section taken through lines 4-4 of FIG. 1.

[0015] FIG. 5 is a section taken through lines 5-5 of FIG. 1.

[0016] FIG. 6 is a section taken through lines 6-6 of FIG. 1.

[0017] FIG. 7 is an elevation illustrating the support of a composite floor on the shear panel of FIG. 1.

DETAILED DESCRIPTION OF A PREFERRED EMBODIMENT

[0018] With reference to the figures where like numerical designations have been used for like elements, FIG. 1 illustrates one embodiment of the shear panel comprising a pair of generally C-shaped vertical truss members 10, 12. As used herein, the term “C-shaped” is inclusive of members with a base and two generally parallel legs extending from the ends thereof in the same direction regardless of the orientation in space, i.e., such members may also be referred to as “U-shaped”.

[0019] These truss members 19,12 may be of any suitable conventional cross-sectional configuration and desirably have the configuration shown in FIGS. 4 and 6 and in the Collins U.S. Pat. No. 6,658,809 dated Dec. 9, 2003, the disclosure of which is hereby incorporated herein by reference.

[0020] The truss members 10, 12 are open towards each other so as to receive between the generally parallel arms or legs thereof the ends of horizontal web members 14, 16 and non-horizontal web members 18, 20 and 22. Each of the web members 14-22 is desirably a box beam of generally square cross-section and may be of any suitable conventional configuration. In the preferred embodiment illustrated, the box configuration of the web members results from the assembly of two generally C-shaped truss members as shown in FIG. 5 and in the Collins U.S. Pat. No. 6,658,809 dated Dec. 9, 2003 and its divisional application published as Publication No. 2004/0118073 dated Jun. 24, 2004, the disclosure of both of which is hereby incorporated herein by reference.

[0021] In the preferred embodiment of FIG. 1, the ends of the web members 14-22 may be secured to the truss members 10, 12 in any suitable conventional manner, e.g., buy self threading fasteners. However, it may be preferable to secure the members by welding.
The topmost web member 14 may be used, as shown in FIG. 7, as a floor joist to support a deck 24 extending normal thereto. Conventional commodity deck roll formed with alternating crests and valleys may be used as well as various proprietary decks. Concrete 26 may be poured on top of the deck to the desired depth to create a steel/concrete composite floor.

The web member 16 may be omitted where the floor is to be supported as described above. However, the horizontal web member 16 may be attached to the truss members 10, 12 in the same manner as the web members 14 and may be used to support suitable conventional spaced apart floor trustees or joists 27 at the upper surface of which may be used to support the floor.

The three web members 18, 20 and 22 are disposed at angles to the horizontal to provide structural stability to the panel. The angles of the web members 18 and 20 to the vertical is desirably decreased where the web member 16 is omitted.

The adjacent ends of the web members 20 and 22 are desirably separated sufficiently to provide a horizontal path for conduit, e.g., electrical wiring and/or plumbing, through the panel without passing through any of said web members.

The passage of wiring or plumbing through the closed side of the truss members 10, 12 may be provided by drilling appropriate apertures on site or by knock-outs or apertures provided in the fabrication of the panel. Such apertures may also be provided in the fabrication of the panels.

The fabrication of the shear panel may be done at the building site, but is more easily accomplished at an assembly site and shipped to the building site.

The location of the shear panels on the lowest floor, often a concrete slab, may be accomplished through the use of base plates 30 as shown in FIGS. 2 and 3. The base plates may be made of heavy metal and may include a flat plate apertured for attachment to the slab by suitable conventional means. Desirably, the base plate includes a generally rectangular cross-section housing suitable to telescopingly receive therein the lower end of the truss member 10 of the shear panel.

With continued reference to FIGS. 1, 6 and 7, the problem of alignment of a shear panel on one floor with that on the floor above may be addressed by the use of alignment members 28. The alignment members 28 are desirably generally C-shaped in cross-section to facilitate insertion between the upper web member 14 and the truss member 10 as shown in FIG. 6. The alignment members 28 may be significantly shorter than the height of the vertical truss members 10, 12 and are less than about one fourth of the height of the vertical truss members 10, 12.

In the embodiment illustrated in FIG. 6, each of the C-shaped alignment member 28 may be formed by two I-shaped members 28a and 28b. These alignment members 28 are desirably driven into place in the panel slightly deforming the truss member 10 and web 14 in the process, and conventionally secured thereto. The alignment members 28 are desirably welded in place during the fabrication of the panel. However, they may be placed and welded or otherwise secured in place on site.

As shown in FIG. 7, the alignment member 28 has sufficient length to extend above the floor to be supported by the shear panel, and when put in place before the floor is poured, will provide an alignment post over which the lower end of a shear panel on the floor above may be mounted in the manner shown in FIG. 6. This eliminates the need for base plates on floors above the slab. The shear panel on the upper floor may be welded or otherwise secured to the exposed alignment members to provide the through-floor connection of the panels.

In the construction of the buildings, the base plates 30 may be attached to the slab. Alignment members may be inserted in the base plates so that the shear panels may be raised and mated thereto. Alternatively, the lower ends of the panels may be mated with the base plates without the use of alignment members. Thereafter, depending on whether the floor is to be supported on top of the web members 14 or on top of floor joists 27 supported on the web members 16, the floor joists may be attached. The floor may then be provided leaving the tops of the alignment members 28 extending above the level of the floor where they serve the same alignment function as the base plates on the slab and a through-floor connection of shear panels. The thickness of the floor provides additional stability for the alignment members 28 and thus the shear panels to be erected thereon.

As is readily apparent, the system and method of the present invention is advantageous in many aspects. The panels are constructed of light gage steel which may be easily roll formed and fabricated for shipment to the building site for erection. The panels provide space for wiring and plumbing and the flexibility of the use of several types of floor joists and a variety of different types of floors. Alignment and stability is provided by the use of alignment members prior to the completion of the floor.

While preferred embodiments of the present invention have been described, it is understood that the embodiments described are illustrative only and the scope of the invention is to be defined solely by the appended claims when accorded a full range of equivalence, many variations and modifications naturally occurring to those of skill in the art from a perusal hereof.

What is claimed is:

1. A shear panel for light gage steel framed construction comprising:

- Two spaced apart, vertical truss members, each truss member being of formed of light gage steel and having a generally C-shaped cross-section with the open side thereof facing the open side of the other of said two vertical truss members;

- A horizontal upper web member being formed of light gage steel and having a generally square cross-section with the opposite ends thereof extending into said two vertical truss members through the open side thereof adjacent the upper end of said two truss members and being secured thereto so that the upward facing surface of said upper web member is adapted to support a floor; and

- At least two non-horizontal, non-parallel web members each formed from light gage steel and having a generally square cross-section, the opposite ends of said non-parallel members extending into said two vertical truss members through the open side thereof intermediate the height thereof and being secured thereto.

2. The shear panel of claim 1 further comprising two vertical alignment members, each vertical alignment member being formed of light gage steel and having a generally
C-shaped cross-section and a height less than about one fourth the height of said vertical truss members,
the lower end of each of said two alignment members being nested in the top end of one of said vertical truss members between the vertical truss member and one end of said horizontal web member and being secured to both said vertical truss member and said horizontal web member, the upper end of each of said alignment members vertically extending above the upward facing horizontal surface of said horizontal web member a distance greater than the thickness of the floor to be supported thereon to facilitate the alignment of, and connection to, a shear panel supported by the floor.

3. The shear panel of claim 2 wherein the generally C-shape cross-section of said alignment members is formed by two generally L-shaped members.

4. The shear panel of claim 2 wherein each of said vertical truss members comprises in cross-section:
   a base; and two substantially parallel legs extending in the same direction from the longitudinal edges of said base over the length thereof at a substantially right angle thereto,
   each of said legs comprising: a first outer face adjacent said base; a web attachment face, the plane of the web attachment face being substantially parallel to the plane of said first outer face; a portion interconnecting said first outer face and said web attachment face, said interconnecting portion extending inwardly at a substantially right angle from the distal edge of said first outer face and outwardly at a substantially right angle from the longitudinal edge of said web attachment face adjacent said base; and a reinforcement flange extending from the distal edge of said web attachment face over a portion of the length thereof said flange comprising a lateral flange portion extending outwardly at a substantially right angle from the distal edge of said web attachment face and an outer flange face extending toward said base at a substantially right angle from the outer edge of said lateral flange portion, said outer flange face being substantially coplanar with said first outer face.

5. The shear panel of claim 4 wherein said the longitudinal width of the legs of said vertical truss members is greater than the longitudinal width of the base, and said reinforcement flange extends from the distal edge of said web attachment face over the length thereof.

6. The shear panel of claim 1 wherein each of said web members comprises a pair of elongated members, each of said members comprising in cross-section a web and two flanges extending from the longitudinal edges of said web in the same direction at a substantially right angle thereto, one of said flanges extending farther from said web than the other of said flanges, each of said flanges terminating in an inwardly turned lip extending toward the other of the flanges, said members being nested so that the shorter of the flanges of each member is adjacent to and inside of the longer of the flanges of the other member so that the two nested members form a generally box-shaped web member.

7. The shear panel of claim 1 wherein said web members are secured to said truss members by welding.

8. The shear panel of claim 1 wherein said non-horizontal webs are three in number.

9. The shear panel of claim 8 wherein the adjacent ends of the lower two of said non-horizontal webs are spaced apart to provide room for conduit to pass horizontally through the panel without passing through any of said webs.

10. The shear panel of claim 1 where the lowest end of the lowest non-horizontal web is spaced from the lower end of the vertical truss to which secured to avoid interference of said web with the on-site mounting of said vertical truss on a preexisting upright.

11. The shear panel of claim 10 further comprising a second horizontal web member formed from light gage steel and having a generally square cross-section with the opposite ends thereof extending into said two vertical truss members through the open side between said first horizontal web member and the uppermost of said non-parallel web members and being secured thereto,
   the upward facing surface of said second horizontal web member being adapted to support one or more floor trusses with the upward facing surface thereof level with the upper surface of said first horizontal web member.

12. A shear panel for light gage steel framed construction comprising:
   two spaced apart, vertical truss members, each truss member being of formed of light gage steel and having a generally C-shaped cross-section with the open side thereof facing the open side of the other of said two vertical truss members;
   a horizontal upper web member being formed of light gage steel and having a generally square cross-section with the opposite ends thereof extending into said two vertical truss members through the open side thereof at a point spaced from the upper end of said two truss members and being secured thereto so that the upward facing surface of said upper web member is adapted to support one or more floor trusses with the upper surface thereof at the height of the upper end of said two vertical trusses; and
   at least two non-horizontal, non-parallel web members each formed from light gage steel and having a generally square cross-section, the opposite ends of said non-parallel members extending into said two vertical truss members through the open side thereof intermediate the height thereof and being secured thereto.

13. The shear panel of claim 12 further comprising two vertical alignment members, each vertical alignment member being formed of light gage steel and having a generally C-shaped cross-section and a height less than about one fourth the height of said vertical truss members,
   the lower end of each of said two alignment members being nested in the top end of one of said vertical truss members between the vertical truss member and one end of said horizontal web member and being secured to both said vertical truss member and said horizontal web member, the upper end of each of said alignment members vertically extending above the upward facing horizontal surface of said horizontal web member a distance greater than the thickness of the floor to be supported thereon to facilitate the alignment of, and connection to, a shear panel supported by the floor.

14. The shear panel of claim 12 wherein the generally C-shape cross-section of said alignment members is formed by two generally L-shaped members.

15. The shear panel of claim 14 wherein each of said vertical truss members comprises in cross-section:
a base; and two substantially parallel legs extending in the same direction from the longitudinal edges of said base over the length thereof at a substantially right angle thereto,
each of said legs comprising: a first outer face adjacent said base; a web attachment face, the plane of the web attachment face being substantially parallel to the plane of said first outer face; a portion interconnecting said first outer face and said web attachment face, said interconnecting portion extending inwardly at a substantially right angle from the distal edge of said first outer face and outwardly at a substantially right angle from the longitudinal edge of said web attachment face adjacent said base; and a reinforcement flange extending from the distal edge of said web attachment face over a portion of the length thereof said flange comprising a lateral flange portion extending outwardly at a substantially right angle from the distal edge of said web attachment face and an outer flange face extending toward said base at a substantially right angle from the outer edge of said lateral flange portion, said outer flange face being substantially coplanar with said first outer face.

16. The shear panel of claim 15 wherein said the longitudinal width of the legs of said vertical truss is greater than the longitudinal width of the base, and said reinforcement flange extends from the distal edge of said web attachment face over the length thereof.

17. The shear panel of claim 12 wherein each of said web members comprises a pair of elongated members, each of said members comprising in cross-section a web and two flanges extending from the longitudinal edges of said web in the same direction at a substantially right angle thereto, one of said flanges extending farther from said web than the other of said flanges, each of said flanges terminating in an inwardly turned lip extending toward the other of the flanges, said members being nested so that the shorter of the flanges of each member is adjacent to and inside of the longer of the flanges of the other member so that the two nested members form a generally box-shaped web member.

18. The shear panel of claim 12 wherein said web members are secured to said truss members by welding.

19. The shear panel of claim 12 wherein said non-horizontal webs are three in number.

20. The shear panel of claim 19 wherein the adjacent ends of the lower two of said non-horizontal webs are spaced apart to provide room for conduit to pass horizontally through the panel without passing through any of said webs.

21. The shear panel of claim 1 wherein the lowest end of the lowest non-horizontal web is spaced from the lower end of the vertical truss to which secured to avoid interference of said web with the on-site mounting of said vertical truss on a preexisting upright.

22. The method of building construction using prefabricated shear panels aligned and structurally connected at the building site comprising the steps of:
(a) providing a first floor;
(b) installing a base plate on the floor;
(c) providing plural prefabricated light gage shear panels, each of said panels being fabricated off-site and including (i) two spaced apart, vertical truss members having a generally C-shaped cross-section and the open side thereof facing the open side of the other of said two vertical truss members, (ii) a horizontal upper web member having a generally square cross-section with the opposite ends thereof extending into said two vertical truss members through the open side thereof adjacent the upper end of said vertical two truss members and being secured thereto so that the upward facing surface of said upper web member is adapted to support a floor, (iii) at least two non-horizontal, non-parallel web members having a generally square cross-section, the opposite ends of said non-parallel members extending into said two vertical truss members through the open side thereof intermediate the height thereof and being secured thereto, and (iv) alignment members extending vertically upward from said vertical truss members a distance greater than the height of the floor to be provided;
(d) mounting one panel on the base member;
(e) providing a floor supported by the horizontal web member with the upper surface thereof at the height of the upper ends of the vertical trusses so that the alignment members extend upwardly above the floor;
(f) mounting one of the panels onto the alignment member so that the shear panels on successive floors are aligned; and
(g) securing the upper floor vertical truss members to the alignment members of the lower floor panel so that the shear panels on successive floors are structurally connected.

23. The method of claim 22 wherein the horizontal web member is attached to the vertical truss members at the upper end thereof; and wherein the floor is provided by supporting a metal deck on the horizontal web member and pouring concrete on top of the deck to a height less than the height of the alignment members.

24. The method of claim 22 wherein the horizontal web member is attached to the vertical truss members at a point spaced from the upper end thereof; and wherein the floor is provided by supporting one of more floor truss members on the horizontal web member and supporting a floor on the floor truss members, the height of the floor being less than the height of the alignment members.

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