Support structures formed from triangular elements

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Publication Classification

ABSTRACT

A support structure for use in buildings, vehicle cargo holds, containers, and similar enclosures. The structure typically employs a plurality of triangular-shaped elements that form a low-profile structural support member. The structures may be formed from sheet material, such as galvanized steel or aluminum using cold roll-forming or bending (press brake) technology. Various embodiments may also be formed from metal or polymers using extrusion technology. These support structures are particularly well suited for applications in building walls or roof panelized systems as supporting elements.
FIG. 9B

FIG. 10

FIG. 11
SUPPORT STRUCTURES FORMED FROM TRIANGULAR ELEMENTS

GOVERNMENT RIGHTS

[0001] This invention was made with government support under Contract No. DE-AC05-00OR22725 awarded by the U.S. Department of Energy. The government has certain rights in the invention.

FIELD

[0002] This disclosure relates to the field of support structures. More particularly, this disclosure relates to support structures formed from sheet-like materials.

BACKGROUND

[0003] Buildings and containers are fabricated from support structures that are generally characterized as columns, studs, trusses, planks, joists, girders and similar load-bearing and decorative elements. Many of the current implementations of these construction materials are fabricated from wood, concrete, or steel. Wooden structural members are often excessively heavy or bulky, and unless they are chemically treated they are combustible and subject to decomposition by rotting or insect destruction. Concrete structural elements are relatively heavy and they have to be reinforced to carry structural loads. Many heavy duty steel structural materials are also excessively heavy in relation to their load-bearing ability. Light-gage steel profiles have usually large cross-section (webs) which complicates overall design of building envelopes, which very often have very limited thickness. What are needed therefore are lighter-weight, more compact and more durable support structures for construction applications. These new structural members would offer significant reduction of the profile cross section with improved structural performance at the same time.

SUMMARY

[0004] The present disclosure provides a support structure that includes a first tubular member having a first generally triangular cross-section with a first face and an opposing first vertex and a second tubular member having a second generally triangular cross-section with a second face and an opposing second vertex. The first face and the second face are disposed substantially on a common first plane and the first vertex and the second vertex are connected by a planar member. Furthermore, the first generally triangular cross-section and the second generally triangular cross-section are separated by only one substantially un-partitioned third generally triangular space.

[0005] A further embodiment provides a support structure formed from a continuous folded sheet having a first edge portion, a second edge portion, and a central portion between the first edge portion and the second edge portion. The first edge portion has a first generally triangular cross-sectional tube having a first face and an opposing first vertex and the second edge portion forms a second generally triangular cross-sectional tube having a second face and an opposing second vertex. The first face and the second face are disposed substantially on a common first plane and the central portion forms a planar member that connects the first vertex and the second vertex. Furthermore, the first generally triangular cross-sectional tube and the second generally triangular cross-sectional tube are separated by only one substantially un-partitioned third generally triangular cross-sectional tube.

[0006] In another embodiment a support structure is formed by a plurality of segments of material configured to form adjacent generally isosceles triangular tubular un-partitioned passageways each having a base. The passageways are substantially congruent and the orientations of each of the adjacent passageways are inverted from each other so that the bases of the adjacent passageways are disposed on the opposite of two substantially parallel planes.

[0007] A further embodiment provides a support structure that includes a first generally triangular cross-section having a first face and an opposing first vertex formed by a first side and a second side. The second side is disposed at an angle that is substantially non-orthogonal to the first face. The support structure also includes a second generally triangular cross-section that has a second face that is orthogonal to the first face and a third side that is substantially orthogonal to the second face. The third side joins the first vertex to the second face.

BRIEF DESCRIPTION OF THE DRAWINGS

[0008] Various advantages are apparent by reference to the detailed description in conjunction with the figures, wherein elements are not to scale so as to more clearly show the details, wherein like reference numbers indicate like elements throughout the several views, and wherein:

[0009] FIG. 1 is a somewhat-schematic cross section of a support structure embodiment.

[0010] FIG. 2 is a somewhat schematic perspective view of the support structure having the cross section depicted in FIG. 1.

[0011] FIG. 3 illustrates an example flower diagram for a light-gage steel cold roll-formed embodiment.

[0012] FIG. 4 illustrates a somewhat-schematic cross-section configuration.

[0013] FIGS. 5A, 5B, and 5C present illustrations of features of isosceles triangles.

[0014] FIG. 6 is a somewhat-schematic cross section of a support structure embodiment having additionally reinforced exterior edges.

[0015] FIG. 7 is a somewhat-schematic cross section of a support structure embodiment.

[0016] FIG. 8 is a somewhat-schematic cross section of a support structure embodiment.

[0017] FIGS. 9A and 9B are somewhat-schematic cross sections of support structure embodiments having two generally triangular cross-sections.

[0018] FIG. 10 is a somewhat-schematic cross section of a corner assembly embodiment.

[0019] FIG. 11 is a somewhat-schematic cross section of a partition wall assembly.

[0020] FIGS. 12A-12C are illustrations of distinctions between cross-sections that are generally triangular and cross-sections that are not generally triangular.

DETAILED DESCRIPTION

[0021] In the following detailed description of the preferred embodiments, reference is made to the accompanying drawings, which form a part hereof, and within which are shown by way of illustration the practice of specific embodiments of support structures. It is to be understood that other embodi-
ments may be utilized, and that structural changes may be made and processes may vary in other embodiments.

[0022] FIG. 1 illustrates a cross section of an embodiment of a support structure 10. Support structure 10 includes a first generally triangular cross-section 12 and a second generally triangular cross-section 14 which in part divide a trapezoidal space into three adjacent triangles. In the embodiment of FIG. 1, the first generally triangular cross-section 12 and the second generally triangular cross-section 14 are configured as congruent isosceles triangles. The first generally triangular cross-section 12 has a first face 16 and an opposing first vertex 18, formed by a first side 20 and a second side 22 of the first generally triangular cross-section 12. The second generally triangular cross-section 14 has a second face 24 and an opposing second vertex 26 formed by a first side 28 and a second side 30 of the second generally triangular cross-section 14. As used herein, a “face” of a triangle is a designated side of a triangle. In the embodiment of FIG. 1 the first generally triangular cross-section 12 and the first generally triangular cross-section 14 are connected by a planar member 38.

[0023] In FIG. 1 there is a small space 32 between the first side 20 and the second side 22 of the first generally triangular cross-section 12, such that the first side 20 and the second side 22 do not touch each other. Similarly, there is a small space 34 between the first side 28 and the second side 30 of the second generally triangular cross-section 14, such that the first side 28 and the second side 30 do not touch each other. Typically the space (e.g. space 32 or space 34) does not exceed approximately twenty five percent of the actual length of the longer or longest of adjacent sides that form the space. Triangular cross-sections that have sides separated by spaces of this magnitude or less are referred to as substantially contiguous cross-sections.

[0024] In the embodiment of FIG. 1 the first face 16 and the second face 24 are disposed substantially in a common first plane 36. The first vertex 18 and the second vertex 26 are connected by a planar member 38. In the embodiment of FIG. 1 the planar member 38 is on a second plane 40 that is substantially parallel to the first plane 36. Further, the first generally triangular cross-section 12 and the second generally triangular cross-section 14 are separated by only one substantially un-partitioned generally triangular space (defined by a passageway 66).

[0025] In the embodiment of FIG. 1 a distance 42 separates the first plane 36 and the second plane 40. That is, the first face 16 (of the first generally triangular cross-section 12) and the second face 24 (of the second generally-triangular cross-section 14) are separated from the planar member 38 by a distance 42. Generally the distance 42 ranges from approximately one and one half to three and three quarters inch. The width 44 of the support structure 10 can typically vary between six and fifteen inches. The typical dimensions indicated here for the distance 42 and the width 44 are not limitations for all embodiments. These dimensions may vary considerably from embodiment to embodiment. In the embodiment of FIG. 1 the support structure 10 has a generally trapezoidal profile and the width (i.e. width 44) of the support structure 10 is at least twice the height (i.e., distance 42) of the support structure 10. In other embodiments the width of a support structure may be less than twice the height of the support structure. A structure having a width that is at least twice its height is referred to as a “low-profile structure.”

[0026] In the embodiment of FIG. 1 a first tab 46 adjoins the first side 20 of the first generally triangular cross-section 12 and a second tab 48 adjoins the first side 28 of the second generally triangular cross-section 14. The first tab 46 and the second tab 48 are generally approximately ¼ inch long and are disposed substantially parallel to the planar member 38. In the embodiment of FIG. 1 an optional first weld 50 attaches the first tab 46 to the planar member 38, and an optional second weld 52 attaches the second tab 48 to the planar member 38. The optional first weld 50 and the optional second weld 52 may be spot welds or continuous welds. In some embodiments the first tab 46 and the second tab 48 may be attached to the planar member 38 by other thermal-joining processes such as soldering or brazing, or may be joined by one or more mechanical fasteners, or may be joined by an adhesive. Some embodiments may not include either the optional weld 50 or the optional second weld 52 or any comparable affixing mechanism. In some embodiments the tab 56 may be folded toward and disposed adjacent the second side 22 (instead of adjacent the planar member 38) and in some embodiments the second tab 58 may be folded toward and disposed adjacent the second side 30. Some embodiments may not include the first tab 46 or the second tab 48. In the case of extruded or pultruded cross-sections the first sides (20 and 28), the second sides (22 and 30) may be joined to the planar member 38 as a web structure. In some embodiments the first sides 20 and 22 (as well as 28 and 30) may not be connected to the planar member 38.

[0027] Support structure 10 is formed from a continuous folded sheet 54 of material that has a first edge 56 and an opposing second edge 58. The combination of the first tab 46, the first side 20, the first face 16 and the second side 22 of the first generally triangular cross-section 12 form a first edge portion of the continuous folded sheet 54. The combination of the second tab 48, the first side 28, the second face 24 and the second side 30 of the second generally triangular cross-section 14 form a second edge portion of the continuous folded sheet 54. The planar member 38 is a central portion of the continuous folded sheet 54. As seen in FIG. 2, the first edge portion forms a first generally triangular cross-sectional tube 60 and the second edge portion forms a second generally triangular cross-sectional tube 62. Referring back to FIG. 1, the first generally triangular cross-sectional tube 60 has a first face 16 and an opposing first vertex 18, and the second generally triangular cross-sectional tube 62 has a second face 24 and an opposing second vertex 26. The faces 20 and 28 and the planar member 38 form a third generally triangular cross-sectional tube 72. The first face 16 and the second face 24 are disposed substantially on a common first plane 36 and the central portion of the continuous folded sheet 54 forms a planar member 38 that joins the first vertex 18 and the second vertex 26. Further, the first generally triangular cross-sectional tube 60 and the second generally triangular cross-sectional tube 62 are separated by only one substantially un-partitioned third generally triangular cross-sectional tube 72.

[0028] Support structures (e.g. support structure 10) may be fabricated with standard cold roll-forming equipment similar to that may be used to form conventional C-shaped light-gage steel studs. For example, FIG. 3 illustrates a “flower diagram” for roll-forming support structure 10, where the process starts with the flat sheet 102 at step 0, and the finished support structure 10 is formed at step 25.

[0029] FIG. 4 illustrates a cross-section of a structure 80 and illustrates terminology that may be applied to support structures. The structure 80 includes a first generally triangu-
lar cross-section 82 and a second generally triangular cross-section 84. The first generally triangular cross-section 82 has a first face 86 and an opposing first vertex 88, formed by a first side 90 and a second side 92 of the first generally triangular cross-section 82. The second generally triangular cross-section 84 has a second face 94 and an opposing second vertex 96 formed by a first side 98 and a second side 100 of the second generally triangular cross-section 94. In the structure 80 of FIG. 4 the first face 86 and the second face 94 are disposed substantially in a common first plane 106. The first vertex 88 and the second vertex 96 are connected by a planar member 108. The planar member 108 is on a second plane 110 that is substantially parallel to the first plane 106 and the second plane 110 is separated from the first plane 106 by a distance 112. The structure 80 has a width 114. The first generally triangular cross-section 82 and the second generally triangular cross-section 84 are separated by a partitioned third generally triangular space 136. That is, the generally triangular space 136 is formed from two triangles 136a and 136b. Furthermore, generally triangular space 136 is partitioned by a divider 140.

[0030] Continuing with terminology illustrated in FIG. 4, the structure 80 is formed from a continuous folded sheet 124 of material that has a first edge 126 and an opposing second edge 128, and a first edge portion and a second edge portion. The planar member 108 forms a central portion of the continuous folded sheet 124 that separates the first edge portion and the second edge portion of the continuous folded sheet 124. The first edge portion forms a first generally triangular cross-sectional tube 130 and the second edge portion forms a second generally triangular cross-sectional tube 132. The first generally triangular cross-sectional tube 130 has a first face 86 and an opposing first vertex 88, and the second generally triangular cross-sectional tube 132 has a second face 94 and an opposing second vertex 96. The first face 86 and the second face 94 are disposed substantially on a common first plane 106 and the central portion of the continuous folded sheet 124 forms a planar member 108 that joins the first vertex 88 and the second vertex 96. The first sides 90 and 98 and the planar member 108 form a third generally triangular cross-sectional tube 142. However, the third generally triangular cross-sectional tube 142 is not substantially un-partitioned. That is, divider 140 partitions generally triangular cross-sectional tube 142. Also, the first generally triangular cross-sectional tube 130 and the second generally triangular cross-sectional tube 132 are separated by two generally triangular cross-sectional tubes, 144 and 146. The structure 80 has a generally trapezoidal profile. The width 114 of the structure 80 is approximately equal to the height of the structure 80, (i.e., the distance 112) and consequently the structure 80 is not a low-profile structure.

[0031] FIGS. 5A, 5B, and 5C illustrate the orientation of the base of an isosceles triangle. A first triangle 220 has two equal length sides 222 and 236, and a shorter third side 234. The two equal-length sides 222 and 236 establish that first triangle 220 is an isosceles triangle. Conventionally, and as used here, the “base” of an isosceles triangle (that is not also an isosceles triangle) is the side of the triangle (e.g., side 234 in this case) that is not equal length. As seen in FIG. 5B, a second isosceles triangle 238 has two equal length sides 240 and 242 and a longer third side 244. The side 244 is the base of the isosceles triangle 238. As seen in FIG. 5C, a third triangle 246 has three equal-length sides 248, 250 and 252. The triangle 246 is special case of an isosceles triangle: an equilateral triangle. Since the sides are all equal in length any of the sides 248, 250, or 252 may be arbitrarily designated the base of the isosceles triangle 246.

[0032] Referring back to FIG. 2, the support structure 10 is formed by a plurality of segments of material (in this case, continuous folded sheet 54) that is configured to form adjacent, congruent, generally isosceles triangular passageways 64, 66, and 68. Referring back to FIG. 1, the passageway 64 has a first face 16 that is also the base of generally isosceles triangular passageway 64 and that is also the base of first generally triangular cross-section 12. The passageway 68 has a second face 24 that is also the base of generally isosceles triangular passageway 68 and that is also the base of second generally triangular cross-section 14. The passageway 66 has a face 38 that is also the base of generally isosceles triangular passageway 66. The first side 20 of the first generally triangular cross-section 12 and the second side 28 of the second generally triangular cross-section 14 form two sides of the passageway 66, and there is a small space 70 between those sides. Typically the space (e.g., space 70) between the sides of the passageway (e.g., 66) does not exceed approximately twenty five percent of the length of the longer or longest of the two sides (in this case, the longer of face 16 or face 24) that form the space 70. Passageways that have sides separated by spaces of this magnitude or less are referred to as substantially contiguous passageways.

[0033] As seen in FIG. 2, the orientations of each of the adjacent, congruent, generally isosceles triangular passageways (adjacent passageways 64 and 66, and adjacent passageways 66 and 68) are inverted from each other so that the base (face 16) of passageway 64 and the base (face 38) of passageway 66 are disposed on the opposite of two substantially parallel planes (i.e., 40 and 36), and the base (face 38) of passageway 66 and the base (face 24) of passageway 68 are disposed on the opposite of the two substantially parallel planes (i.e., 40 and 36).

[0034] FIG. 6 illustrates a further embodiment of a support structure 260. The support structure 260 includes a first tubular member 262 having a first generally triangular cross-section with a first face 264 and an opposing first vertex 266, and a second tubular member 268 having a second generally triangular cross-section with a second face 270 and an opposing second vertex 272. The first face 264 and the second face 270 are disposed substantially on a common first plane and the first vertex and the second vertex are connected by a planar member 274. The first generally triangular cross-section and the second generally triangular cross-section are separated by only one substantially un-partitioned generally triangular space (defined by a passageway 294).

[0035] Further, the support structure 260 of FIG. 6 is formed from a continuous folded sheet 280 having a first edge portion, a second edge portion, and a central portion 274 between the first edge portion and the second edge portion. The first edge portion forms a first generally triangular cross-sectional tube 262 having a first face 264 and an opposing first vertex 266 and the second edge portion forms a second generally triangular cross-sectional tube 268 having a second face 270 and an opposing second vertex 272. The first face 264 and the second face 270 are disposed substantially on a common first plane and the central portion 274 forms a planar member that connects the first vertex and the second vertex. The first generally triangular cross-sectional tube 262 and the second generally triangular cross-sectional tube 268 are separa-
rated by only one substantially un-partitioned third generally triangular cross-sectional tube 282.

[0036] As also illustrated in FIG. 6, the support structure 260 formed by a plurality of segments of material configured to form adjacent un-partitioned generally isosceles triangular tubular passageways 290, 292, and 294. Each of the passageways 290, 292, and 294 has a base (faces 264, 270 and 274, respectively). The passageways 290 292 and 294 are substantially congruent and the orientations of each of the adjacent passageways are inverted from each other so that the bases of the adjacent passageways are disposed on the opposite of two substantially parallel planes.

[0037] FIG. 7 illustrates a further embodiment of a support structure 310. The support structure 310 includes a first tubular member 312 having a first generally triangular cross-section with a first face 316 and an opposing first vertex 318, and a second tubular member 314 having a second generally triangular cross-section with a second face 324 and an opposing second vertex 326. The first face 316 and the second face 324 are disposed substantially on a common first plane and the first vertex 318 and the second vertex 326 are connected by a planar member 338. The first generally triangular cross-section and the second generally triangular cross-section are separated by only one substantially un-partitioned generally triangular space (defined by a passageway 394).

[0038] Further, the support structure 310 of FIG. 7 is formed from a continuous folded sheet 330 having a first edge portion, a second edge portion, and a central portion 338 between the first edge portion and the second edge portion. The first edge portion forms a first generally triangular cross-sectional tube 360 having a first face 316 and an opposing first vertex 318 and the second edge portion forms a second generally triangular cross-sectional tube 362 having a second face 324 and an opposing second vertex 326. The first face 316 and the second face 324 are disposed substantially on a common first plane and the central portion 338 forms a planar member that connects the first vertex 318 and the second vertex 326. The first generally triangular cross-sectional tube 360 and the second generally triangular cross-sectional tube 362 are separated by only one substantially un-partitioned third generally triangular cross-sectional tube 372.

[0039] FIG. 8 illustrates a cross section of an embodiment of a support structure 410. Support structure 410 includes a first generally triangular cross-section 412 and a second generally triangular cross-section 414 which in part divide a trapezoidal space into three adjacent triangles. In the embodiment of FIG. 8 the first generally triangular cross-section 412 and the second generally triangular cross-section 414 are configured as isosceles triangles. The first generally triangular cross-section 412 has a first face 416 and an opposing first vertex 418, formed by a first side 420 and a second side 422 of the first generally triangular cross-section 412. The second side 422 is disposed at an angle 423 that is substantially non-orthogonal to the first face 416. In some embodiments the angle 423 is substantially 45°. The second generally triangular cross-section 414 has a second face 424 and an opposing second vertex 426 formed by a first side 428 and a second side 430 of the second generally triangular cross-section 414. In the embodiment of FIG. 8 the first generally triangular cross-section 412 and the first generally triangular cross-section 414 are connected by a planar member 438.

[0040] In FIG. 8 there is a small space 432 between the first side 420 and the second side 422 of the first generally triangular cross-section 412, such that the first side 420 and the second side 422 do not touch each other. Similarly, there is a small space 434 between the first side 428 and the second side 430 of the second generally triangular cross-section 414, such that the first side 428 and the second side 430 do not touch each other. Typically the space (e.g. space 432 or space 434) does not exceed approximately twenty five percent of the actual length of the longer or longest of adjacent sides that form the space.

[0041] In the embodiment of FIG. 8 the first face 416 and the second face 424 are disposed substantially in a common first plane 436. The second side 430 of the second generally triangular cross-section 414 is disposed substantially orthogonal to the common first plane 436. The first vertex 418 and the second vertex 426 are connected by a planar member 438. In the embodiment of FIG. 8 the planar member 438 is on a second plane 440 that is substantially parallel to the first plane 436. Further, the first generally triangular cross-section 412 and the second generally triangular cross-section 414 are separated by only one substantially un-partitioned generally triangular space (defined by a passageway 466).

[0042] In the embodiment of FIG. 8 a distance 442 separates the first plane 436 and the second plane 440. That is, the first face 416 (of the first generally triangular cross-section 412) and the second face 424 (of the second generally-triangular cross-section 414) are separated from the planar member 438 by a distance 442. Generally the distance 442 ranges from approximately one and one half to three and three quarters inch. The width 444 of the support structure 410 can typically vary between six and fifteen inches. The typical dimensions indicated here for the distance 442 and the width 444 are not limitations for all embodiments. These dimensions may vary considerably from embodiment to embodiment. In the embodiment of FIG. 8 the support structure 410 has a generally trapezoidal profile and the width (i.e. width 444) of the support structure 410 is at least twice the height (i.e., distance 442) of the support structure 410. In other embodiments the width of a support structure may be less than twice the height of the support structure.

[0043] Support structure 410 is formed from a continuous folded sheet 454 of material that has a first edge 456 and an opposing second edge 458. The combination of the first side 420, the first face 416 and the second side 422 of the first generally triangular cross-section 412 form a first edge portion of the continuous folded sheet 454. The combination of the first side 428, the second face 424 and the second side 430 of the second generally triangular cross-section 414 form a second edge portion of the continuous folded sheet 454. The planar member 438 is a central portion of the continuous folded sheet 454. The first edge portion forms a first generally triangular cross-sectional tube 460 and the second edge portion forms a second generally triangular cross-sectional tube 462. The first generally triangular cross-sectional tube 460 has a first face 416 and an opposing first vertex 418, and the second generally triangular cross-sectional tube 462 has a second face 424 and an opposing second vertex 426. The faces 420 and 428 and the planar member 438 form a third generally triangular cross-sectional tube 472. The first face 416 and the second face 424 are disposed substantially on a common first plane 436 and the central portion of the continuous folded sheet 454 forms a planar member 438 that joins the first vertex 418 and the second vertex 426. Further, the first generally triangular cross-sectional tube 460 and the second generally triangle cross-sectional tube 462 are sepa-
rated by only one substantially un-partitioned third generally triangular cross-sectional tube 472.

Fig. 9A illustrates a cross section of a further embodiment of a support structure 510. Support structure 510 includes a first generally triangular cross-section 512 and a second generally triangular cross-section 514 which in part divide a trapezoidal space into two adjacent triangles. The first generally triangular cross-section 512 has a first face 516 and an opposing first vertex 518, formed by a first side 520 and a second side 522 of the first generally triangular cross-section 512. The second side 522 is disposed at an angle 523 that is substantially non-orthogonal to the first face 516. In some embodiments the angle 523 is substantially 45°. The second generally triangular cross-section 514 has a second face 524 that is substantially orthogonal to the first face 516 of the first generally triangular cross section 512 and the second generally triangular cross section 514 has a third side 528 that is substantially orthogonal to the second face 524 and the third side 528 joins the first vertex 518 to the second face 524. The support structure 510 is formed from a continuous folded sheet 554. In the previously-described support structures 10, 260, 310, and 410, both edges of the continuous folded sheets that form those support structures are disposed at a position that is interior to the support structure. That configuration provides a measure of intrinsic strength to the support structure. In the support structure 510 one edge 558 is disposed exterior to the support structure. In this embodiment a weld 560 or similar bonding element may be used to enhance the strength of the support structure 510.

In the embodiment of Fig. 9A a distance 542 separates the first face 516 of the first generally triangular cross-section 512 and the third side 528 of the second generally triangular cross section 514. Generally the distance 442 ranges from approximately one and one half to three and three quarters inch. The width 544 of the support structure 510 can typically vary between three and eight inches. The typical dimensions indicated here for the distance 542 and the width 544 are not limitations for all embodiments. These dimensions may vary considerably from embodiment to embodiment. In the embodiment of Fig. 9A the support structure 510 has a generally trapezoidal profile and the width (i.e., width 544) of the support structure 510 between 12.5% and up to twice the height (i.e., distance 542) of the support structure 510. In other embodiments the width of a support structure may be less than twice the height of the support structure. A structures having a width between 125% and up to twice its height is referred to as a “mid-profile structure.”

Fig. 9B illustrates a support structure 570 that is similar to support structure 510 depicted in Fig. 9A. However, the first side 580 of the first generally triangular cross section 582 includes a tab 584. Furthermore, the second generally triangular cross-section 586 of the support structure 570 has an enclosing portion 586 that is formed separate from the first side 580 of the first generally triangular cross-section 582. The enclosing portion 586 includes a tab 588. Some embodiments may not include the tab 584 or the tab 588. Note that in the support structure 570, both edges (590 and 592) of the continuous folded sheet 594 that forms the support structure 570 are disposed interior to the support structure 570. The support structure 510 of Fig. 9A and the support structure 570 of Fig. 9B may, for example, be utilized in window and/or door jambs.

Fig. 10 depicts certain details of a corner assembly 610 embodiment. The corner assembly 610 includes a first support structure 620 and a second support structure 630. The first and second support structures 620 and 630 are similar to the support structure 410 depicted in Fig. 8. In the embodiment of Fig. 10, the first and second support structures (620 and 660) have slightly different dimensions. In other corner assembly embodiments two support structures having substantially the same dimensions may be used, such as the support structures 410 depicted in Fig. 8 where the angle 423 is substantially 45°.

Fig. 11 depicts certain details of a partition wall assembly 640. The partition wall assembly 640 includes a first support structure 650, a second support structure 660, and a third support structure 670. The first, second and third support structures (650, 660, and 670) are similar to the support structure 410 depicted in Fig. 8. In the embodiment of Fig. 11, the first and second support structures (650 and 660) have substantially the same dimensions. The third support structure 670 has dimensions that are slightly different from the first and second support structures (650 and 660). In other partition wall assembly embodiments three support structures having substantially the same dimensions may be used, such as the support structures 410 depicted in Fig. 8 where the angle 423 is substantially 45°.

Figs. 12A, 12B and 12C illustrate the concept of “generally triangular” shapes as the term is used herein. Fig. 12A illustrates a “generally triangular” shape 700. Generally triangular shape 700 is generally triangular because its contour fits between the sides of a first virtual triangle 710 and a second virtual triangle 720, where the first virtual triangle 710 and the second virtual triangle 720 are congruent and concentric and where the length of each side of the second virtual triangle 720 is one-half the length of the corresponding side of the first virtual triangle 710. The specific shapes and scale of the first virtual triangle 710 and the second virtual triangle 720 are not important in determining whether a shape (e.g., 700) is “generally triangular.” If a shape fits between the sides of any pair of congruent and concentric virtual triangles of any shape and scale, where the length of each side of the inner triangle is one-half the length of the corresponding side of the outer triangle, the shape is “generally triangular.” In some embodiments a shape fits between the sides of any pair of congruent and concentric virtual triangles of any shape and scale, where the length of each side of the inner triangle is three-fourths of the length of the corresponding side of the outer triangle. Such shapes are referred to as “substantially triangular.” Similarly, a shape is “substantially isosceles triangular” if it fits between the sides of any pair of congruent and concentric virtual isosceles triangles, where the length of each side of the inner isosceles triangle is three-fourths of the length of the corresponding side of the outer isosceles triangle. Further, a shape is “substantially right triangular” if it fits between the sides of any pair of congruent and concentric virtual right triangles, where the length of each side of the inner right triangle is three-fourths of the length of the corresponding side of the outer right triangle.

Figs. 12A and 12C illustrate a shape 730 that is somewhat similar to generally triangular shape 700. However the contour of the shape 730 does not fit between the sides of the first virtual triangle 710 and the second virtual triangle 720, regardless of whether the first virtual triangle 710 and the second virtual triangle 720 are oriented with bases down (as in Fig. 12B) or bases up (as in Fig. 12C). Nor (it is postulated) does the contour of shape 730 fit between the sides of any pair of congruent and concentric virtual triangles of any
shape, where the length of each side of the inner triangle is one-half the length of the corresponding side of the outer triangle. Consequently, shape 730 is not “generally triangular.”

Embodiments described herein are significantly stronger than most current light-gage C-shaped or Z-shaped steel profiles. Various embodiments may be formed from many different materials including sheet material, such as galvanized steel or aluminum, or from polymers or composites. As previously indicated, these support structures may be formed by cold roll-forming. They may also be formed using bending (press brake) technology, or extrusion or pultrusion technology. These support structures are particularly well suited for applications in building walls or roof panelized systems as supporting elements. Embodiments may also be used in the construction of over-the-road truck and vehicle trailers and cargo enclosures, railroad cars, packing boxes, pallets, and so forth.

The foregoing descriptions of embodiments have been presented for purposes of illustration and exposition. They are not intended to be exhaustive or to limit the embodiments to the precise forms disclosed. Obvious modifications or variations are possible in light of the above teachings. The embodiments are chosen and described in an effort to provide the best illustrations of principles and practical applications, and to thereby enable one of ordinary skill in the art to utilize the various embodiments as described and with various modifications as are suitably contemplated to the particular use contemplated. All such modifications and variations are within the scope of the appended claims when interpreted in accordance with the breadth to which they are fairly, legally, and equitably entitled.

What is claimed is:

1. A support structure comprising:
   a first tubular member having a first generally triangular cross-section with a first face and an opposing first vertex;
   a second tubular member having a second generally triangular cross-section with a second face and an opposing second vertex; wherein
   the first face and the second face are disposed substantially on a common first plane and the first vertex and the second vertex are connected by a planar member, and wherein the first generally triangular cross-section and the second generally triangular cross-section are separated by only one substantially un-partitioned generally triangular space.

2. The support structure of claim 1 wherein the planar member is disposed on a second plane that is substantially parallel to the first plane.

3. The support structure of claim 2 wherein the support structure is a low-profile structure.

4. The support structure of claim 1 further comprising a space between the first face and the second face.

5. The support structure of claim 1 wherein the first cross-section and the second cross-section are substantially congruent.

6. The support structure of claim 1 wherein the structure is formed from a continuous folded sheet.

7. The support structure of claim 1 wherein the structure is formed as an extrusion.

8. The support structure of claim 1 wherein the first and second triangular cross-sections form substantially isosceles triangles.

9. The support structure of claim 1 wherein the first and second triangular cross-sections form substantially right triangles.

10. A support structure formed from a continuous folded sheet having a first edge portion, a second edge portion, and a central portion between the first edge portion and the second edge portion, wherein the first edge portion comprises a first generally triangular cross-sectional tube having a first face and an opposing first vertex and the second edge portion forms a second generally triangular cross-sectional tube having a second face and an opposing second vertex, wherein the first face and the second face are disposed substantially on a common first plane and wherein the central portion forms a planar member that connects the first vertex and the second vertex, and wherein the first generally triangular cross-sectional tube and the second generally triangular cross-sectional tube are separated by only one substantially un-partitioned third generally triangular cross-sectional tube.

11. The support structure of claim 10 wherein the planar member is disposed on a second plane that is substantially parallel to the first plane.

12. The support structure of claim 10 wherein the support structure is a low-profile structure.

13. The support structure of claim 10 further comprising a space between the first face and the second face.

14. The support structure of claim 10 wherein the first cross-section and the second cross-section are substantially congruent.

15. The support structure of claim 10 wherein the first and second triangular cross-sections form substantially isosceles triangles.

16. The support structure of claim 10 wherein the first and second triangular cross-sections form substantially right triangles.

17. A support structure formed by a plurality of segments of material configured to form adjacent un-partitioned generally isosceles triangular tubular passageways each having a base, wherein the passageways are substantially congruent and the orientations of each of the adjacent passageways are inverted from each other so that the bases of the adjacent passageways are disposed on the opposite of two substantially parallel planes.

18. The support structure of claim 17 wherein the support structure is a low-profile structure.

19. The support structure of claim 17 wherein the plurality of segments of sheet material are formed from a continuous folded sheet.

20. The support structure of claim 17 wherein the structure is formed as an extrusion.

21. A support structure comprising:
   a first generally triangular cross-section having a first face and an opposing first vertex formed by a first side and a second side wherein the second side is disposed at an angle that is substantially non-orthogonal to the first face;
   a second generally triangular cross-section having second face that is orthogonal to the first face and a third side that is substantially orthogonal to the second face and wherein the third side joins the first vertex to the second face.

22. The support structure of claim 21 wherein the angle is substantially 45°.