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(54) **WOOD-STEEL COMPOSITE STRUCTURAL BEAM**

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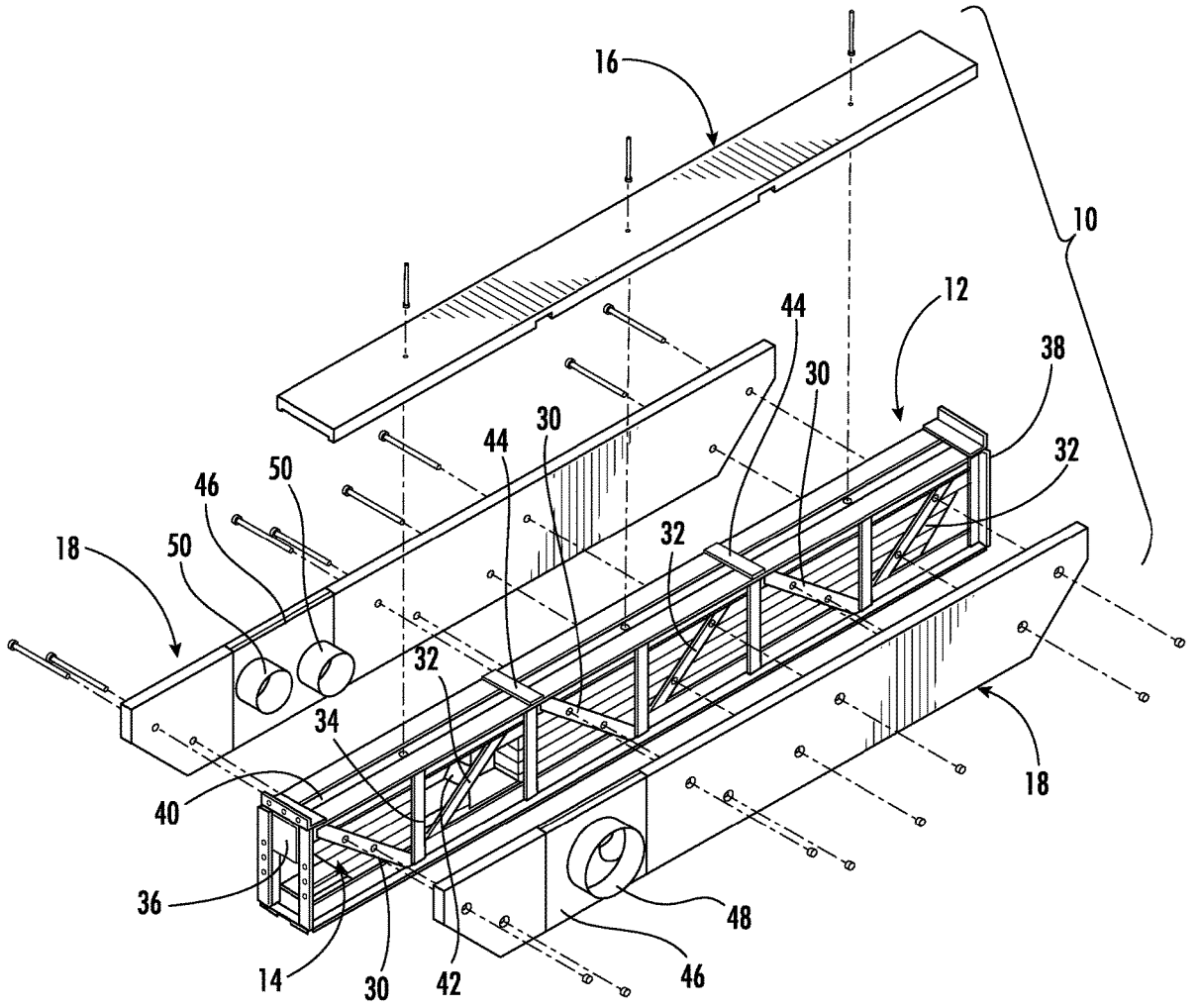
(57) **ABSTRACT**

A composite structural beam includes a metal frame including frame members extending along at least three axes. The metal frame defines an interior cavity. An internal wood member is located within the interior cavity and is configured to provide structural support to the metal frame. At least one external wood member is connected to the metal frame such that at least a portion of the metal frame is captured between the at least one external wood member and the internal wood member.



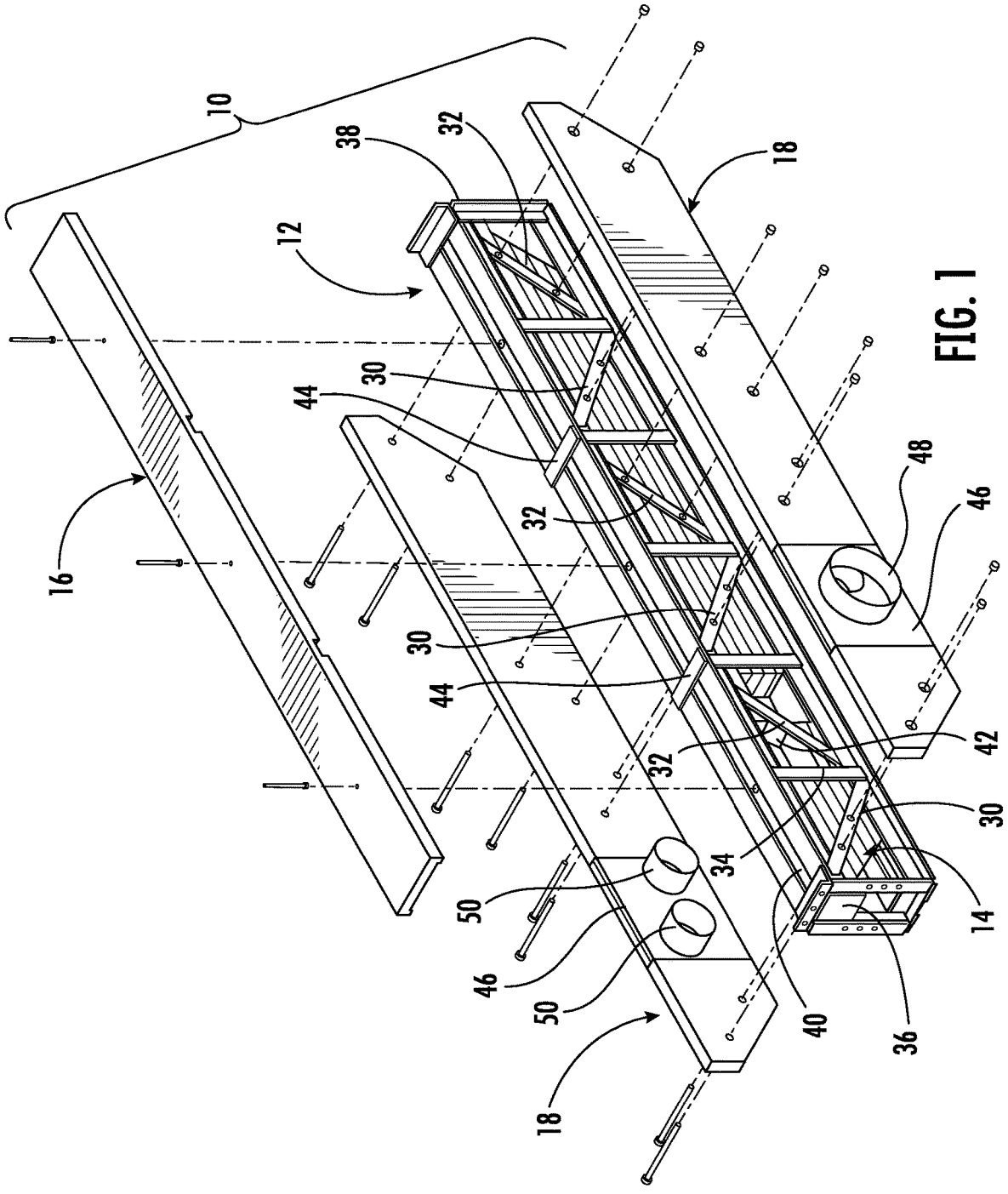


FIG. 1

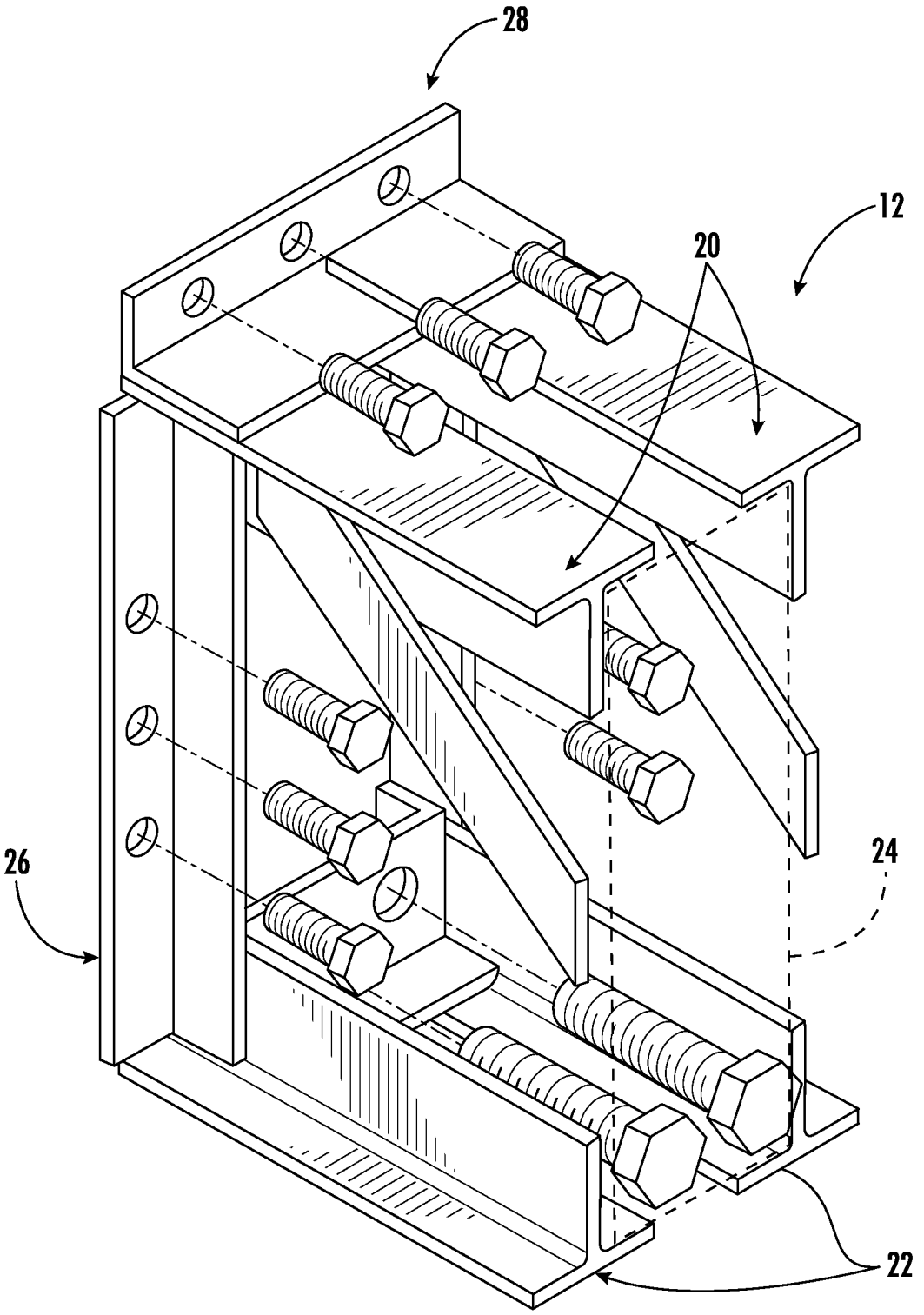


FIG. 2

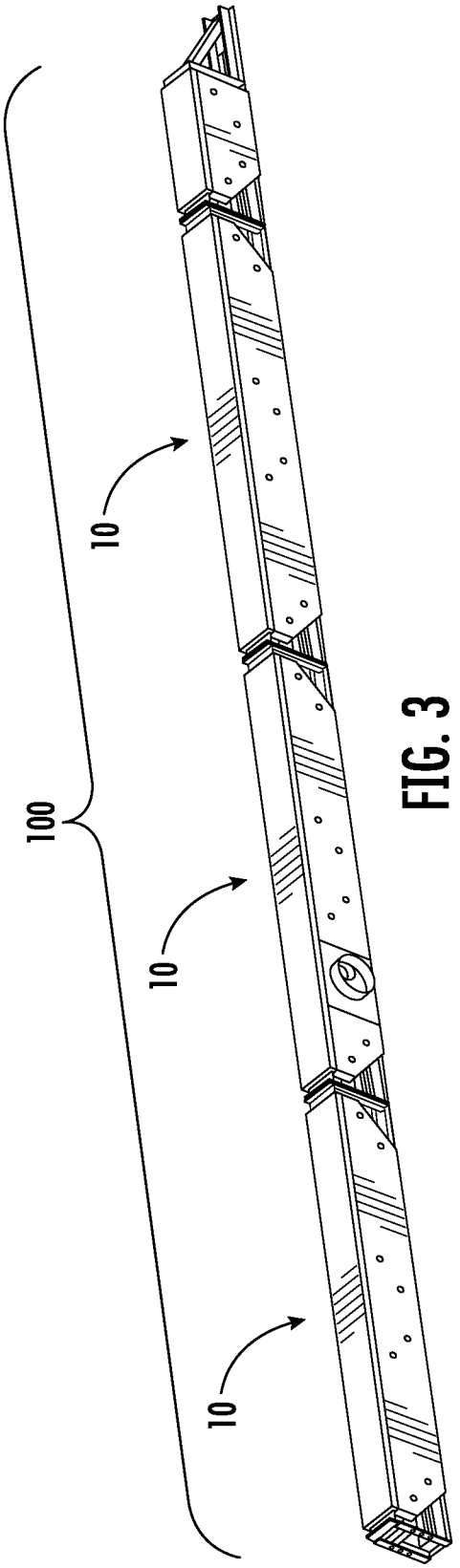


FIG. 3

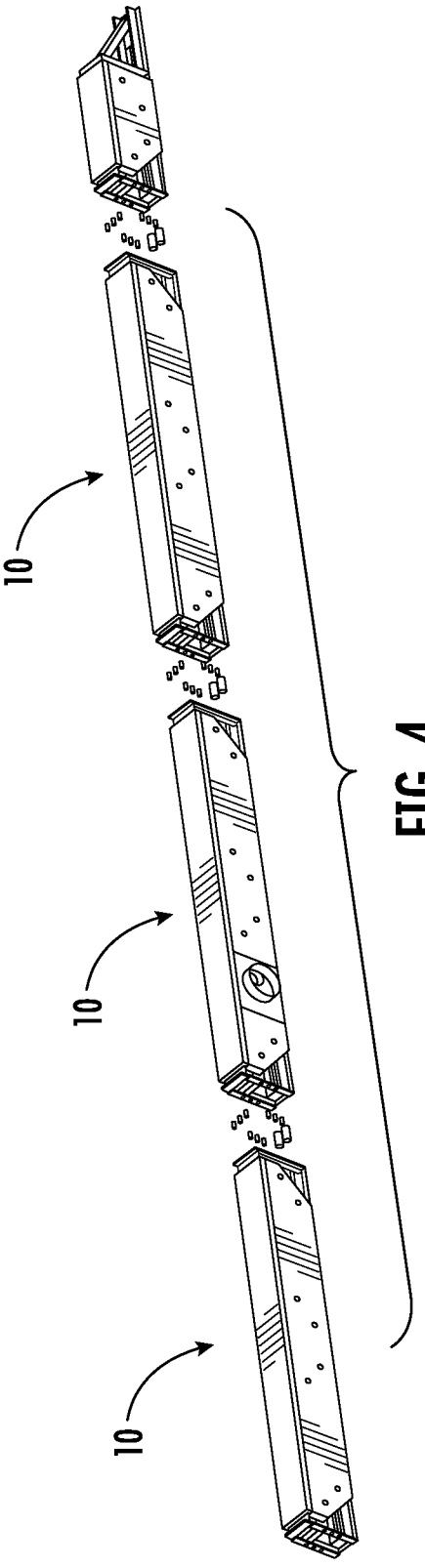


FIG. 4

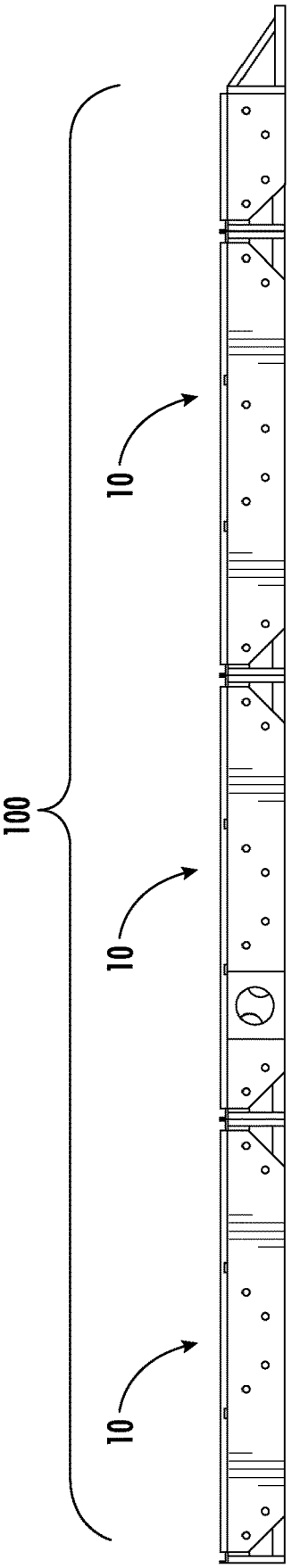


FIG. 5

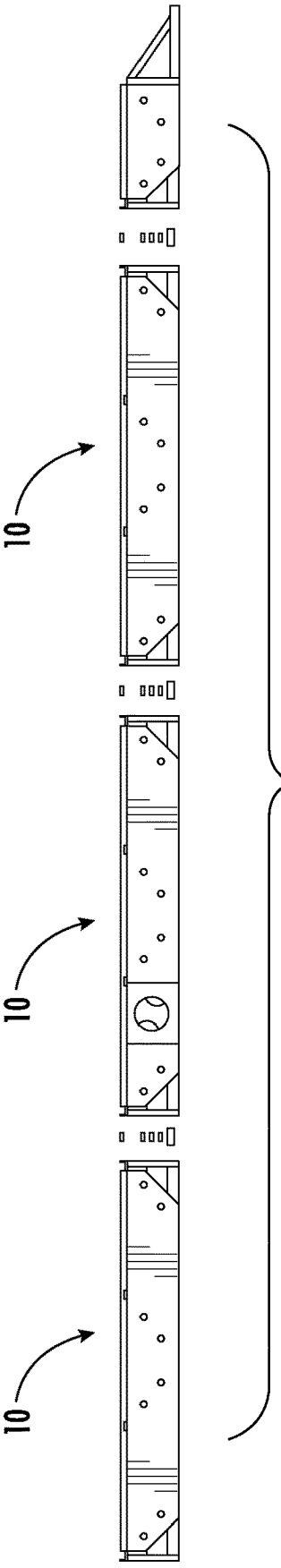


FIG. 6

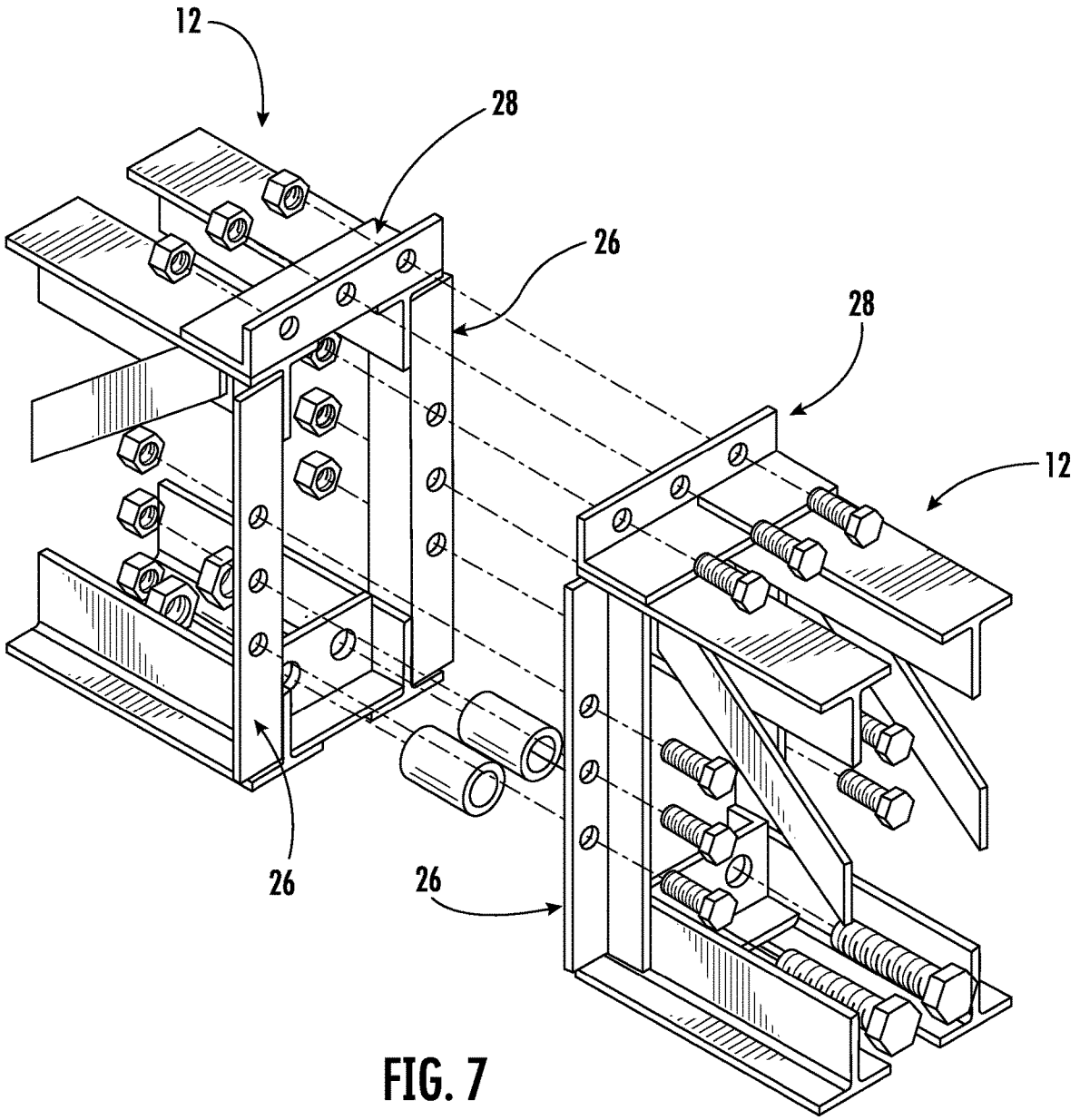


FIG. 7

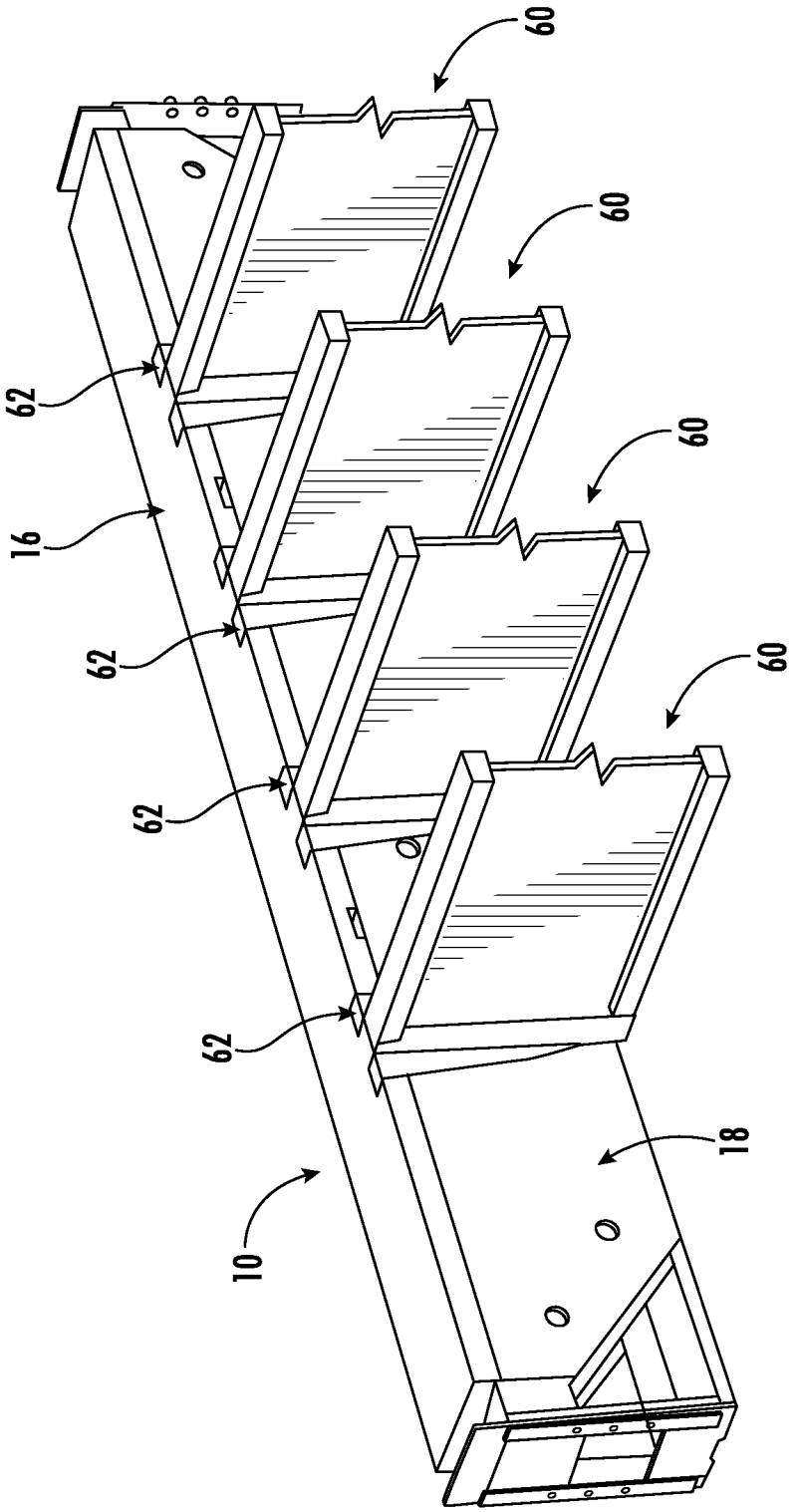


FIG. 8

WOOD-STEEL COMPOSITE STRUCTURAL BEAM

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application claims the benefit of U.S. Provisional Application Ser. No. 62/233,498, filed Aug. 16, 2021, the contents of which are expressly incorporated herein by reference.

STATEMENT RE: FEDERALLY SPONSORED RESEARCH/DEVELOPMENT

[0002] Not Applicable

BACKGROUND

1. Technical Field

[0003] The present disclosure relates generally to a structural beam, and more specifically to a composite beam formed of both wood and steel.

2. Description of the Related Art

[0004] Structural beams are commonly used in the construction industry to provide strength and stability to a structure. For instance, a beam may be used to support the weight of floors, ceilings, and roofs and may transfer a load to a vertical load bearing element of the structure. Structural beams are commonly formed of wood, due to its availability and ease in forming into the desired size and length. Furthermore, wood is an easy material to work with when attaching additional structures, such as joists, to the beam.

[0005] Although wood provides certain advantages as a material for structural beams, there are also some limitations or deficiencies associated with wood. For instance, wood beams may be limited in their ability to span across long lengths and retain their structural characteristics. Accordingly, steel is an alternative material that is commonly used, particularly when a beam with a long span is needed. Steel may also allow for increased strength capacity when compared to wood. However, while steel beams provide certain advantages, there are also disadvantages associated with steel beams. For instance, steel beams tend to be more costly than wood beams, and may be difficult to attach structures, such as joists thereto.

[0006] In conventional construction, structural beams typically intersect, or cross paths with air ducts. It tends to be difficult to cut holes in conventional structural beams, while also maintaining the integrity of such beams. As such, in some instances, air ducts may be routed around the structural beams, which may take up valuable space and add additional cost to a construction project.

[0007] Accordingly, there is a need in the art for a beam that incorporates that advantages of both steel and wood beams, while also mitigating disadvantages that may be associated with those materials. Various aspects of the present disclosure address this particular need, as will be discussed in more detail below.

BRIEF SUMMARY

[0008] In accordance with one embodiment of the present disclosure, there is provided a composite structural beam comprising a metal frame including frame members extending along at least three axes. The metal frame defines an interior cavity. An internal wood member is located within the interior cavity and is configured to provide structural support to the metal frame. At least one external wood member is connected to the metal frame such that at least a portion of the metal frame is captured between the at least one external wood member and the internal wood member.

[0009] The frame members may include a first pair of T-bars, with each T-bar including a first portion and a second portion perpendicular to the first portion. The frame members may also include a second pair of T-bars. The internal wood member may be disposed within a central cavity defined by the first and second pairs of T-bars.

[0010] The internal wood member may be a laminated wood member. The internal wood member may be sized to extend between opposed portions of the internal cavity such that the internal wood member is in abutting contact with opposed portions of the metal frame.

[0011] The frame members may include a first corner bracket having a pair of flanges in orthogonal relation to each other, with the first corner bracket being located at a first end portion of the metal frame. The frame members may include a second corner bracket having a pair of flanges in orthogonal relation to each other, the second corner bracket being located at the first end portion of the metal frame and extending in orthogonal relation to the first corner bracket.

[0012] The internal wood member may include a wood member void and the metal frame may include a frame member void aligned with the wood member void. The composite structural beam may additionally include a utility duct aligned with the wood member void and the frame member void. The utility duct may include a collar portion and a plate portion circumnavigating the collar portion. The plate portion may include at least one surface co-planar with a surface of the at least one external wood member.

[0013] According to another embodiment, there is provided a modular composite beam comprising a plurality of beam modules. Each beam module includes a metal frame including frame members extending along at least three axes. The metal frame defines an interior cavity. An internal wood member is located within the interior cavity and is configured to provide structural support to the metal frame. At least one external wood member is connected to the metal frame such that at least a portion of the metal frame is captured between the at least one external wood member and the internal wood member.

[0014] The present disclosure will be best understood by reference to the following detailed description when read in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0015] These and other features and advantages of the various embodiments disclosed herein will be better understood with respect to the following description and drawings, in which:

[0016] FIG. **1** is a partially exploded, upper perspective view of a wood-steel composite structural beam;

[0017] FIG. **2** is an upper perspective, cross sectional view of a steel frame of the beam of FIG. **1**;

[0018] FIG. **3** is an upper perspective view of a plurality of beams interconnected to each other to form an elongate beam assembly;

[0019] FIG. **4** is an upper perspective view of the plurality of beams of FIG. **3** disconnected from each other;

[0020] FIG. **5** is a front view of the elongate beam assembly of FIG. **3**;

[0021] FIG. **6** is a front view of the plurality of beams of the elongate beam assembly with the plurality of beams disconnected from each other;

[0022] FIG. **7** is an upper perspective view illustrating interconnection of adjacent metal frames in respective structural beams to each other; and

[0023] FIG. **8** is an upper perspective view of a plurality of joists connected to the structural beam.

[0024] Common reference numerals are used throughout the drawings and the detailed description to indicate the same elements.

DETAILED DESCRIPTION

[0025] The detailed description set forth below in connection with the appended drawings is intended as a description of certain embodiments of a wood-steel composite structural beam and is not intended to represent the only forms that may be developed or utilized. The description sets forth the various structure and/or functions in connection with the illustrated embodiments, but it is to be understood, however, that the same or equivalent structure and/or functions may be accomplished by different embodiments that are also intended to be encompassed within the scope of the present disclosure. It is further understood that the use of relational terms such as first and second, and the like are used solely to distinguish one entity from another without necessarily requiring or implying any actual such relationship or order between such entities.

[0026] Referring now to the drawings, wherein the showings are for purposes of illustrating preferred aspects of the present disclosure, and are not for purposes of limiting the same, there is depicted a wood-steel composite beam **10** that provides the functional advantages of wood with the strength of steel. The beam **10** may generally include a steel frame **12**, as well as an internal wood member **14**, and a plurality of external wood members **16**, **18**. Portions of the steel frame **12** may be captured between the internal wood member **14** and the external wood members **16**, **18** to provide lateral support to the steel frame **12** to mitigate buckling thereof. The external wood members **16**, **18** may also provide easy to access mounting locations for joists or other structural members that may be attached to the beam.

[0027] Referring now first to FIG. **1**, one embodiment of the beam **10** is depicted with the internal wood member **14** being located within the steel frame **12**, and the external wood members **16**, **18** being exploded from the frame **12** to more clearly illustrate the configuration of the steel frame **12** and the internal wood member **14**. As shown more clearly in FIG. **2**, the steel frame **12** may extend along three axes so as to define a length, a width, and a height, with the frame **12** including a pair of upper T-bars **20** arranged in spaced parallel relation to each other, and a pair of lower T-bars **22** arranged in spaced parallel relation to each other. Each T-bar **20**, **22** includes a vertical portion and a horizontal portion perpendicular to the vertical portion. Each upper T-bar **20** is arranged with the vertical portion extending toward the opposing lower T-bars **22**, and the horizontal portion being generally co-planar with the horizontal portion of the other upper T-bar **20**. Likewise, each lower T-bar **22** is arranged with the vertical portion extending toward the opposing upper T-bars **20**, and the horizontal portion being generally co-planar with the horizontal portion of the other lower T-bar **22**. The vertical portion of the upper and lower T-bars **20**, **22** on a common side may be generally co-planar with each other.

[0028] The vertical portions of the T-bars **20**, **22**, and medial segments of the horizontal portions of the T-bars **20**, **22** may define an internal cavity **24**, within which the internal wood member **14** may reside. In more detail, the internal cavity **24** may be bound by a first plane defined by a first set of aligned vertical portions of the T-bars **20**, **22**, a second plane define by a second set of aligned vertical portions of the T-bars **20**, **22**, a third plane defined by the aligned horizontal portions of the upper T-bars **20**, and a fourth plane defined by the aligned horizontal portions of the lower T-bars **22**.

[0029] The steel frame **12** may additionally include several corner brackets **26**, **28** (e.g., ninety degree brackets) adjacent end portions of the steel frame **12**. In particular, each end portion may include a pair of vertical corner brackets **26**, with each vertical corner bracket **26** extending between a lower T-bar **22** and an upper T-bar **20**. Each end portion may further include a pair of horizontal corner brackets **28**, with each horizontal corner bracket **28** extending across the pair of upper T-bars **20** or the pair of lower T-bars **22**. Each corner bracket **26**, **28** (e.g., both the horizontal and the vertical) may be connected to the corresponding T-bars **20**, **22** via welding, and adhesive, or other mechanical fasteners known in the art.

[0030] Referring back to FIG. **1**, the steel frame **12** may further include several lateral struts **30**, **32** that extend at an angle between an upper T-bar **20** and a lower T-bar **22**. Importantly, one or more voids or openings may be formed between the lateral struts **30**, **32** and the T-bars **20**, **22**, with the opening being sized to accommodate ducting, as will be explained in more detail below.

[0031] In the embodiment shown in FIG. **1**, each side of the steel frame **12** includes a set of three outer lateral struts **30** positioned on the outside of the vertical portions of the T-bars **20**, **22** with the outer lateral struts **30** extending generally parallel to each other (e.g., extending at a common angle relative to the upper and lower T-bars **20**, **22**). Each side of the steel frame **12** additionally includes a set of three inner lateral struts **32** positioned on the inside of the vertical portions of the T-bars **20**, **22** with the inner lateral struts **32** extending generally parallel to each other, and with a slope that is opposite to that of the outer lateral struts **30**. In this regard, in the perspective shown in FIG. **1**, the outer lateral struts **30** extend downwardly in a left to right direction, while the inner lateral struts **32** extend upwardly in a left to right direction. It is understood that the position, number, and orientation of the lateral struts **30**, **32** is merely provided as an example, and is not limited thereto without departing from the spirit and scope of the present disclosure.

[0032] The steel frame **12** may further include several vertical members **34** on each side of the steel frame **12**, with each vertical member **34** extending on the outside of a vertical portion a lower T-bar **22** and a vertical portion of an upper T-bar **20**. The vertical members **34** may be positioned adjacent an apex or intersection defined by adjacent lateral struts **30**, **32**. Although the vertical members **34** are shown as being on the outside of the vertical portions of the T-bars **20**, **22**, it is contemplated that the vertical members **34** may also be located on the inside of the vertical portions of the T-bars **20**, **22** without departing from the spirit and scope of the present disclosure.

[0033] The internal wood member **14** may be configured to occupy a substantial portion of the internal cavity **24** of the steel frame **12**. In particular, the internal wood member **14** may include a first end face **36** and an opposing second end face **38**, with each end face **36**, **38** being disposed adjacent an end portion of the steel frame **12**. The internal wood member **14** may also include an upper face **40** disposed adjacent the horizontal portions of the upper T-bars **20**, and a lower face disposed adjacent the horizontal portions of the lower T-bars **22**.

[0034] The internal wood member **14** may be specifically contoured to include certain cutouts to define voids or openings within the internal cavity **24**. In the embodiment depicted in FIG. **1**, the internal wood member **14** includes a pair of angled faces adjacent respective lower corners of the internal cavity **24**, which creates a void or space having a triangularly shaped cross section.

[0035] The internal wood member **14** may also include a void or space in a middle region of the internal wood member **14** to accommodate ducting. In the exemplary embodiment, a middle void **42** is defined by an upper segment, a lower segment, and a first inner side surface and an opposing second inner side surface. The inner side surfaces may be generally planar or stepped or define another configuration as may be desired to accommodate the configuration of the steel frame **12**, as well as ducting intended to pass through the beam **10**. In this regard, the void **42** may be aligned with a space in the steel frame **12** to provide a passageway through both the steel frame **12** as well as the internal wood member **14**.

[0036] The internal wood member **14** may be a laminated structure or may be formed from one, unitary piece of wood.

[0037] The external wood members **16**, **18** may include upper wood member **16**, and a pair of lateral wood members **18**. Although not shown in the drawings, a lower wood member may also be included. The upper wood member **16** includes a plank or board having an outer face, a sidewall extending around the upper wood member **16** and an inner face opposite the outer face. The inner face may include several cutouts or recesses sized to receive corresponding transverse struts **44** or reinforcement members of the steel frame **12**. The upper wood member **16** may be attached to the internal wood member **14** via several screws or other mechanical fasteners known in the art. The size and shape of the upper wood member **16** may be substantially similar to the configuration of the upper portion of the steel frame **12**, such that the upper wood member **16**, when attached to the internal wood member **14**, covers much of the upper portion of the steel frame **12**. The length of the upper wood member **16** may be substantially equal, yet slightly less, than the distance between the upwardly extending portions of the upper horizontal corner brackets **28**.

[0038] Each lateral wood member **18** may extend over a respective lateral portion of the steel frame **12**. Each lateral wood member **18** may include a plank or board having a lateral face, a sidewall extending around the lateral wood member **18**, and a medial face opposite the lateral face. The lateral wood member **18** may be attached to the steel frame **12** or the internal wood member **14** via several screws or other mechanical fasteners known in the art. The size and shape of the lateral wood member **18** may be substantially similar to the configuration of the lateral portions of the steel frame **12**. According to one embodiment, one or more portions of the lateral wood member **18** may be cutaway or otherwise configured to create a space adjacent the end portions of the steel frame **12** to facilitate attachment of one beam **10** to an adjacent beam **10**, as will be described in more detail below. In the exemplary embodiment, each lateral wood member **18** includes an angled edge to create a triangular space at a lower corner of the beam **10**. It is understood that the size, shape and configuration of the space may vary without departing from the spirit and scope of the present disclosure.

[0039] The lateral wood member **18** may optionally include one or more integrated components configured to accommodate or facilitate passage of ducting through the beam **10**. In the exemplary embodiment, each lateral wood member **18** includes a metal plate **46** integrated therein and connected on either side to wood bodies. The metal plate **46** may include one or more openings formed therein. Each opening may be surrounded by a wall or sleeve **48**, **50** sized and configured to facilitate attachment to a duct element. By allowing the ducting to pass through the beam **10**, a soffit may be avoided, which may allow for a more efficient use of the available space.

[0040] FIGS. **3** and **5** show several beams **10** connected to each other to form a beam assembly **100**, while FIGS. **4** and **6** show the beams **10** in a disconnected state. Referring now to FIG. **7**, there is depicted an enlarged view of an end portion of adjacent steel frames **12**, with several mechanical fasteners also being shown to illustrate attachment of one beam to an adjacent beam. As can be seen, each vertical corner bracket **26** includes three openings formed therein, each of which accommodates a mechanical fastener, which extends through aligned openings on adjacent vertical corner brackets on beams **10** being attached to each other. An upper horizontal corner bracket **28** may include three openings, which also receive three mechanical fasteners. The lower horizontal corner **28** bracket may only include a pair of openings, as the lower horizontal corner bracket may be smaller than the upper horizontal corner bracket, and may reside between the vertical portions of the lower T-bars.

[0041] Each beam **10** may be similarly formed and may be made available in one or more standard lengths, such as eight feet. Thus, multiple beams **10** may be connected to each other to achieve a desired length for the beam assembly **100**.

[0042] FIG. **8** illustrates connection of joists **60** to the beam **10**. The external wood members **16**, **18** allow joists **60** to be connected to the beam **10** using hardware **62** commonly used with conventional wood beams, such as joist hangers.

[0043] As used herein, the word member may broadly refer to a beam, rod, shaft, plank, or other structural element that may be any size, shape or configuration.

[0044] The particulars shown herein are by way of example only for purposes of illustrative discussion, and are not presented in the cause of providing what is believed to be most useful and readily understood description of the principles and conceptual aspects of the various embodiments of the present disclosure. In this regard, no attempt is made to show any more detail than is necessary for a fundamental understanding of the different features of the various embodiments, the description taken with the drawings making apparent to those skilled in the art how these may be implemented in practice.

What is claimed is:

1. A composite structural beam comprising:

a metal frame including frame members extending along at least three axes, the metal frame defining an interior cavity;

an internal wood member located within the interior cavity and configured to provide structural support to the metal frame; and

at least one external wood member connected to the metal frame such that at least a portion of the metal frame is captured between the at least one external wood member and the internal wood member.

2. The composite structural beam recited in claim **1**, wherein the frame members include a first pair of T-bars, each T-bar including a first portion and a second portion perpendicular to the first portion.

3. The composite structural beam recited in claim **2**, therein the frame members include a second pair of T-bars.

4. The composite structural beam recited in claim **3**, wherein the internal wood member is disposed within a central cavity defined by the first and second pairs of T-bars.

5. The composite structural beam recited in claim **1**, wherein the internal wood member is a laminated wood member.

6. The composite structural beam recited in claim **1**, wherein the internal wood member is sized to extend between opposed portions of the internal cavity such that the internal wood member is in abutting contact with opposed portions of the metal frame.

7. The composite structural beam recited in claim **1**, wherein the frame members include a first corner bracket having a pair of flanges in orthogonal relation to each other, the first corner bracket being located at a first end portion of the metal frame.

8. The composite structural beam recited in claim **7**, wherein the frame members include a second corner bracket having a pair of flanges in orthogonal relation to each other, the second corner bracket being located at the first end portion of the metal frame and extending in orthogonal relation to the first corner bracket.

9. The composite structural beam recited in claim **1**, wherein the internal wood member includes a wood member void and the metal frame includes a frame member void aligned with the wood member void.

10. The composite structural beam recited in claim **9**, further comprising a utility duct aligned with the wood member void and the frame member void.

11. The composite structural beam recited in claim **10**, wherein the utility duct includes a collar portion and a plate portion circumnavigating the collar portion, the plate portion having at least one surface co-planar with a surface of the at least one external wood member.

12. A modular composite beam comprising:

a plurality of beam modules, each beam module comprising:

a metal frame including frame members extending along at least three axes, the metal frame defining an interior cavity;

an internal wood member located within the interior cavity and configured to provide structural support to the metal frame; and

at least one external wood member connected to the metal frame such that at least a portion of the metal frame is captured between the at least one external wood member and the internal wood member;

the plurality of beam modules being configured such that adjacent ones of the plurality of beam modules are engageable with each other.

13. The modular composite beam recited in claim **12**, wherein the frame members of each beam module include a first pair of T-bars, each T-bar including a first portion and a second portion perpendicular to the first portion.

14. The modular composite beam recited in claim **13**, therein the frame members of each beam module include a second pair of T-bars.

15. The modular composite beam recited in claim **14**, wherein the internal wood member is disposed within a central cavity defined by the first and second pairs of T-bars.

16. The modular composite beam recited in claim **12**, wherein the internal wood member is a laminated wood member.

17. The modular composite beam recited in claim **12**, wherein the internal wood member is sized to extend between opposed portions of the internal cavity such that the internal wood member is in abutting contact with opposed portions of the metal frame.

18. The modular composite beam recited in claim **12**, wherein the internal wood member includes a wood member void and the metal frame includes a frame member void aligned with the wood member void.

19. The modular composite beam recited in claim **18**, further comprising a utility duct aligned with the wood member void and the frame member void.

20. The composite modular composite structural beam recited in claim **19**, wherein the utility duct includes a collar portion and a plate portion circumnavigating the collar portion, the plate portion having at least one surface co-planar with a surface of the at least one external wood member.

* * * * *