COMPOSITE WALL SYSTEM

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ABSTRACT

A composite wall assembly includes a frame. A sheathing layer of composite material is mounted on the frame. At least one waterproof insulating layer is adhered to the sheathing layer without puncturing the waterproof insulating layer. An outer layer of composite material is adhered to the waterproof insulating layer opposite the sheathing layer without puncturing the outer layer. The sheathing layer and the outer layer may be a magnesium oxide composite board material.
FIG. 6
COMPOSITE WALL SYSTEM

CROSS REFERENCE TO RELATED APPLICATION

[0001] This application claims the benefit of U.S. Provisional Application No. 60/994,695, filed Sep. 21, 2007.

TECHNICAL FIELD

[0002] This invention relates to a composite wall system for a building that can be used either above or below ground, and more particularly to a composite wall system that is highly moisture resistant, thermally efficient, durable, and capable of being quickly constructed in comparison to conventional concrete or frame walls.

BACKGROUND OF THE INVENTION

[0003] Conventional structural wall assemblies are made in various forms. Conventional wall assemblies can be categorized into four basic types:

[0004] 1. Walls using a frame and sheathing;
[0005] 2. Masonry walls such as stone, concrete, brick, or concrete block;
[0006] 3. Composite walls such as a structural insulated panels (SIPs); or

[0008] Walls using a frame and sheathing design typically have a frame made of a load bearing structural material (such as steel studs, wood studs, foam or any other appropriate structural support material) that are arranged vertically (typically 16-24 inches on center) and mechanically fastened at the top and bottom to other structural support members (such as steel C-channel or other appropriate structural material). The members can be attached by various means such as welding, using mechanical fasteners such as screws or nails, using a structural adhesive, or any combination thereof.

[0009] The frame can be reinforced with cross bracing and or strapping that runs vertically, horizontally, or diagonally to strengthen the vertical members. This is a commonly accepted practice to increase the load bearing capacity of a wall. The frame and its various members provide load bearing capacity for both axial loads (downward forces on the wall) and lateral loads (forces perpendicular to the wall). However, the frame alone has very little racking or diaphragm strength (i.e., side forces in the same plane as the wall).

[0010] To obtain the required diaphragm load bearing capacity, sheathing is attached to the frame assembly. The combination of a frame and sheathing is a commonly accepted method for constructing a structural load bearing wall assembly. The sheathing consists of a panel or a series of panels that are attached to one or both sides of the frame assembly. The sheathing can cover the entire frame assembly from top to bottom and from side to side. The sheathing can be made of various materials such as corrugated steel or other metallic sheathing material, plywood, oriented strand board (OSB), cement board, or magnesium oxide (MgO) cement board.

[0011] The sheathing can be mechanically attached to the frame assembly by welding, by using mechanical fasteners such as screws or nails, by using a structural adhesive, or any combination thereof. However, this fastening system or method generally requires mechanical fasteners to provide adequate structural strength to the wall assembly. Unfortunately, the mechanical fasteners puncture the sheathing material, providing passages for water and insects to pass through.

[0012] Further, framed walls do not provide insulation or waterproofing. Typically, insulation is applied to the wall between the framing members. This method of insulation does not insulate between the framing members and the sheathing material. Therefore a path of thermal conductivity between the framing members and the sheathing allows significant heat loss. In addition, walls of this type typically need additional waterproofing treatments or other water-resistant barrier applied to them.

[0013] A second type of structural wall is a masonry wall constructed of stone, brick, concrete, or concrete block. Masonry walls include masonry material interlocked together and secured with concrete or mortar. Some masonry walls also use reinforcing metal bars for added strength. Concrete walls consist of concrete that is mixed and poured into forms. Reinforcing steel bars known as rebar are often used for added strength. Masonry walls have high strength for all three load conditions (axial, lateral, and diaphragm). However, over time masonry walls tend to crack. In addition, masonry walls are not waterproof and they have very poor thermal insulating properties.

[0014] Basement walls for residential buildings have generally been constructed of concrete. Typically, spaced apart vertical forms are assembled at a building site, and concrete is poured into the space defined between the forms. After the concrete has been poured, it must be allowed to set or cure for a period of several days, and often as much as two weeks or even longer. Construction of a building having a poured concrete wall must be completely suspended during the time that the concrete is curing. This delay in construction is undesirable because it can result in higher construction costs.

[0015] Another disadvantage with concrete basement walls is that they have a relatively high capacity for absorbing and conveying moisture through capillary action, and as a result, basements with concrete walls tend to be damp and clammy. A further disadvantage with concrete basement walls is that they have relatively low thermal insulating properties. As a result, basements with concrete walls tend to be relatively cool and generally uncomfortable during the winter months.

[0016] A third type of structural wall is a composite wall made of several layers. The most common is a SIP. A SIP typically includes a layer of structural insulating foam such as polyurethane or polyurethane sandwiched between two outer layers of sheathing such as plywood or OSB. The structural load-bearing capacity derives from the combination of the foam acting as a web and the sheathing acting as a flange. For a SIP, as the thickness of the insulating foam layer is increased, the load bearing capacity of the wall is also improved.

[0017] A SIP provides better insulation than frame walls or masonry walls. However, in order to achieve the required load bearing capacity, a SIP must be reinforced using structural supports such as steel or wood studs that are mechanically fastened to the interior of the structural sheathing. That is, the studs are mechanically fastened between two abutting structural SIP sections such that the studs run vertically along the entire height of the sections and extend horizontally from interior to exterior of the entire SIP wall. The mechanical fasteners are inserted from the outer surfaces of the two outer layers (or two outer structural sheathings) of the SIP wall through to the interior surfaces of the outer layers and into the reinforcing studs.
When this method is used to reinforce a SIP, it creates a thermal break in the insulation and waterproofing features of the walls. Also, a SIP that is constructed using conventional sheathing materials such as plywood or OSB must have a waterproof or water resistive barrier applied to all surfaces outside of the building envelope in order to maintain the integrity of the sheathing material. In addition, SIP walls require passageways or chases to be installed to enable wiring and plumbing to be run through the walls during the construction of a building.

A fourth type of wall is constructed by attaching a SIP to a frame system. This is not a very common type of system because of its high cost; however, some homes have been constructed using these types of walls. These walls also have the additional drawback that mechanical fasteners are used to attach the SIP to the frame, thereby puncturing all of the layers of the entire SIP. Puncturing the SIP creates a path for water migration and a break in the thermal barrier, which over time results in structural degradation and energy loss.

SUMMARY OF THE INVENTION

The present invention provides a composite wall assembly and system that overcomes the disadvantages of conventional walls and provides the strength needed for a structural load bearing wall. The present composite wall system includes a frame that is mechanically fastened to sheathing material. Multiple layers of various materials are then attached to the sheathing material to create a composite wall system. The framed wall and sheathing layer provide the structural load bearing capabilities, while the outer composite layers provide performance enhancing features such as waterproofing, thermal insulation, and impact (i.e., damage) protection.

A composite wall in accordance with the invention includes a frame and a layer of sheathing. The sheathing is attached to the frame by mechanical fasteners that puncture the sheathing material. The combination of the frame and sheathing layer provides for the structural strength of the present composite wall. The present composite wall further includes one or more layers of adhesive applied to the layer of sheathing. One or more layers of an insulating, waterproof foam material are applied to the adhesive layer(s). Finally, one or more layers of material providing impact protection, insect protection, and waterproofing are adhered to the foam material layer(s).

Significantly, at least the outermost exterior layer and preferably any additional composite layers (for example, the aforementioned insulating waterproof foam material layers and additional layers providing impact protection) are attached, directly or indirectly through another layer, to the sheathing of the composite wall without being punctured therethrough (e.g., are devoid of any mechanical fasteners), thereby maintaining their insulating and waterproofing integrity. The additional composite layers may be adhered to the sheathing using a structural adhesive such as polyurethane. Advantageously, the adhesive layer also acts as an additional water-resistive barrier. Since the additional composite layers are not punctured, the present composite wall eliminates the problems of water migration and breaks in the thermal barrier.

The composite layers of the present composite wall system also may provide a number of performance enhancing characteristics in addition to thermal insulation and waterproofing. For example, the composite layers may provide for fireproofing, soundproofing, or weatherproofing. The characteristics of the composite wall system can be varied by changing the specific materials used for the composite layers. It should be understood that a variety of appropriate combinations of composite layers may be used, as long as these layers provide the wall system with the appropriate performance enhancing characteristics (such as fireproofing, sound proofing, insulation and waterproofing), and are not punctured in the assembly.

Sections of the present composite wall system are also uniquely assembled in a manner that forms an entire wall system that maintains the integrity of the composite layers. The present method of assembling the composite wall sections also ensures the elimination of the problems of water migration and breaks in the thermal barrier. More particularly, the present assembly method includes disposing wall sections side by side. The wall sections are attached internally by a combination of mechanical fasteners applied to the structural studs of the frame. Further, a layer of adhesive/sealant is applied between the composite layers so there is no puncturing of the composite layers. This method of construction ensures a monolithic design around a building constructed with the present composite wall system, with no breaks in the composite wall system's thermal insulation or waterproofing features.

In one embodiment, a composite wall assembly in accordance with the present invention includes a frame. A sheathing layer is mounted on the frame. At least one waterproof insulating layer is attached to the sheathing layer. An outer layer of composite material is attached to the waterproof insulating layer opposite the sheathing layer. Significantly, both the waterproofing insulating layer and outer layer are devoid of any mechanical fasteners protruding therethrough (that form puncture holes).

The sheathing layer may be a magnesium oxide composite board material. The waterproof insulating layer may be a foam extruded polystyrene. The outer layer may be a magnesium oxide composite board material. The sheathing layer may be mounted on the frame by a plurality of mechanical fasteners. The waterproof insulating layer and the outer layer may be adhered (via series of adhesive layers) without forming puncture holes through the layers. The frame may include a plurality of spaced studs disposed between first and second end members. The studs may be generally C-shaped and the end members may be C-channels.

Further, a composite wall system in accordance with the present invention includes a first composite wall section and a second composite wall section. The first composite wall section includes a first frame, a first sheathing layer of composite material mounted on the first frame, a first waterproof insulating layer adhered to the first sheathing layer, and a first outer layer of composite material adhered to the first waterproof insulating layer opposite the first sheathing layer, the first outer layer of composite material being devoid of any puncture holes through the first outer layer. The second composite wall section includes a second frame, a second sheathing layer of composite material mounted on the second frame, a second waterproof insulating layer adhered to the second sheathing layer, and a second outer layer of composite material adhered to the second waterproof insulating layer opposite the second sheathing layer, the second outer layer of composite material being devoid of any puncture holes through the second outer layer. The first composite wall section is connected to the second composite wall section through the first and second frames.
The first and second frames may include a plurality of spaced studs. The first composite wall section may be connected to the second composite wall section by mechanical fasteners extending through one stud of the first frame and one adjacent stud of the second frame. A seam between the first and second composite wall sections may be sealed with a sealant adhesive. The composite wall system may also include a connector component disposed between and connected to the first and second composite wall sections, wherein the connector component includes a connector frame, a connector sheathing layer of composite material mounted on the connector frame, a connector waterproof insulting layer adhered to the connector sheathing layer, and a connector outer layer of composite material adhered to the connector waterproof insulting layer opposite the connector sheathing layer. The connector component may be one of a 90° elbow connector, a T-shaped connector, and a Z-shaped connector. The first frame, the second frame, and the connector frame each may include a plurality of spaced studs, wherein the first composite wall section is connected to the connector component by mechanical fasteners extending through one of the studs of the first frame and one adjacent stud of the second frame. A seam between the first composite wall section and the connector component may be sealed with a sealant adhesive, and a seam between the second composite wall section and the connector component may be sealed with a sealant adhesive. The first and second composite wall sections may be erected on a concrete footing. A waterproof membrane may be disposed between the footing and the first and second composite wall sections. The first and second composite wall sections may form walls of a basement.

Furthermore, a method of assembling a composite wall in accordance with the present invention includes the steps of constructing a frame including a plurality of spaced studs disposed between first and second end members, mounting a sheathing layer of composite material on the frame with mechanical fasteners extending through the sheathing layer and the studs, adhering at least one waterproof insulting layer to the sheathing layer without puncturing the waterproof insulting layer, and adhering an outer layer of composite material to the waterproof insulting layer opposite the sheathing layer without puncturing the outer layer.

The sheathing layer and the outer layer may be made of a magnesium oxide composite board material.

These and other features and advantages of the invention will be more fully understood from the following detailed description of the invention taken together with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

In the drawings:

FIG. 1 is an elevational cutaway view of a composite wall in accordance with the invention;

FIG. 2 is a cross-sectional view of the composite wall taken along the line 2-2 in FIG. 1;

FIG. 3 is an enlarged view of upper and lower portions of the composite wall of FIG. 2;

FIG. 4 is a partial view of a stud mounted in a stud track forming in part a lower end portion of the composite wall;

FIG. 5 is a sectional view of composite wall illustrating a seam between two composite wall sections that are mounted together;

FIG. 6 is a sectional view of a composite wall illustrating a connector component;

FIG. 7 is a sectional view of a composite wall illustrating a corner connector component;

FIG. 8 is an elevational cutaway view of a composite wall in accordance with the invention mounted on a concrete footing and installed as a basement wall;

FIG. 9 is a cross-sectional view of the composite wall taken along the line 9-9 in FIG. 8; and

FIG. 10 is an enlarged view of upper and lower portions of the composite wall of FIG. 9.

DETAILED DESCRIPTION OF THE INVENTION

With reference to FIGS. 1 through 4, in a specific embodiment, a composite wall assembly 20 in accordance with the invention includes a frame 22. The frame 22 includes a plurality of elongated studs 24 disposed generally parallel to and spaced from each other. For example, the studs 24 may be 16-gauge galvanized steel studs assembled vertically and spaced 16 inches on center, although larger or smaller spacing distances can be used.

Each stud 24 may have a body 26 and a flange 28 extending generally perpendicularly from each longitudinal side of the body 26. For example, each stud 24 may have a C-shaped or I-shaped cross-section. The body 26 of each stud 24 also may include a plurality of spacedly disposed openings 30. The openings 30 may be round, oval, oblong, or a similar shape. Due to the openings 30, each stud 24 is low in weight yet structurally strong. Further, the openings 30 in the studs 24 may allow for easy installation of plumbing, electrical wiring, or similar through the studs.

In an alternative embodiment, the studs 24 may be made of a ceramic cement material or similar such as a magnesium oxide (MgO) composite board material comprised of magnesium oxide and other components.

The studs 24 are disposed between and welded to first and second elongated end members 32, 34. The end members 32, 34 may be 16-gauge galvanized steel C-channels (e.g., stud tracks) disposed at bottom and top ends of the studs 24. When mounted to the studs 24, the C-channels 32, 34 form lower and upper ends of the frame 22 of the wall 20. Each C-channel 32, 34 may include a middle portion 36, 38, respectively, and opposite flange portions 40, 42, respectively, extending perpendicular to the middle portion. The ends of each stud 24 generally fit snugly between the flange portions 40, 42 of the C-channels 32, 34. If the studs 24 are made of metal, then it is preferable to also use C-channels 32, 34 made of metal. In this embodiment, the studs 24 may be fixed to the C-channels 32, 34, such as by welding and/or by fasteners, and all the welds may be coated with a rust inhibitor. In the alternative, if the studs 24 are made of MgO board or similar, the C-channels 32, 34 may also be made of the same or a similar material. In this embodiment, the studs 24 may be fixed to the C-channels 32, 34 by fasteners and/or may be bonded to the C-channels with an adhesive or similar. The use of ceramic cement studs and C-channels reduces or eliminates the potential for corrosion of the composite wall and
also reduces the thermal conductivity of the composite wall, making it more thermally efficient.

[0047] Galvanized steel strapping 44 and metal blocking 46 may be horizontally mounted to the steel studs 24 at predefined intervals. The studs 24, C-channels 32, 34, steel strapping 44, and metal blocking 46 together form the steel frame subassembly 22 of the composite wall 20.

[0048] A first, sheathing layer 48 of composite material such as a ceramic cement sheet or similar is mounted on one side of the studs 24. In one embodiment, the composite material may be a sheet of magnesium oxide (MgO) board that is comprised of magnesium oxide and other components. For example, sheathing panels comprising 5/16th of an inch thick MgO boards may be mounted on the steel frame subassembly 22. The sheathing layer 48 of composite material may be the same material as the composite material of the studs 24 (in the embodiment in which the studs are made of composite material). The sheathing layer 48 of composite material may be mounted on the steel frame subassembly 22 by a plurality of mechanical fasteners 50 such as screw fasteners, bolts, nails or similar. In addition, structural polyurethane adhesive (not shown) optionally may be applied to the perimeter of each MgO board panel. The adhesive is applied between the steel frame 22 and the MgO sheathing layer 48 to provide added diaphragm strength to the composite wall assembly 20. The combination of the steel frame 22 and the MgO sheathing 48 provides for the structural capacity (i.e., mechanical strength) of the composite wall assembly 20. The composite sheathing layer 48 functions as a structural member of the composite wall 20 and carries loads on the wall to the studs 24. The composite sheathing layer 48 also adds transverse and racking strength to the composite wall assembly 20.

[0049] A waterproof insulating layer 52 is mounted to a side face of the composite sheathing layer 48 that faces away from the steel frame 22. The waterproof insulating layer 52 covers over the fasteners 50 that mount the composite sheathing layer 48 to the studs 24. The waterproof insulating layer 52 may be a styrofoam or styrofoam-like material such as a foam extruded polystyrene or similar. One suitable material is PC-30 STYROFOAM Panel Core sold by The Dow Chemical Company. Alternatively, the waterproof insulating layer 52 may be a foam-like material made of cement. The waterproof insulating layer 52 may be bonded to the composite sheathing layer 48 with adhesive (not shown) such as a polyurethane adhesive or similar. The polyurethane adhesive is applied between the composite sheathing layer 48 and the waterproof insulating layer 52. Since the foam waterproof insulating layer 52 is adhered to the composite sheathing layer 48, the waterproof insulating layer is not pierced, thereby providing a waterproof barrier that prevents the passage of water to the composite sheathing layer 48 and studs 24 of the composite wall assembly 20 structure. The waterproof insulating layer 52 may be two pound polystyrene foam having a thickness of approximately 2 inches, although thicknesses greater or less than 2 inches are within the scope of the invention.

[0050] A second, outer layer 54 of composite material is mounted to a side face of the waterproof insulating layer 52 that faces away from the composite sheathing layer 48. The outer layer 54 of composite material may be of the same composition as the sheathing layer 48 of composite material. For example, the outer layer 54 of composite material may be 5/16 inch thick MgO board. The outer composite layer 54 may be bonded to the waterproof insulating layer 52 with an adhesive (not shown) such as a polyurethane adhesive or similar. The polyurethane adhesive is applied between the waterproof insulating layer 52 and the outer composite layer 54. The adhesive that adheres the outer composite layer 54 to the waterproof insulating layer 52 may be of the same composition as the glue/adhesive that adheres the waterproof insulating layer 52 to the composite sheathing layer 48. The outer composite layer 54 forms an outer layer of the composite wall assembly 20 and protects the waterproof insulating layer 52 from structural damage. For example, if the composite wall 20 is used to form a basement wall, the outer composite layer 54 protects the waterproof insulating layer 52 from damage during backfill of the basement excavation. The outer composite layer 54 also protects the composite wall assembly 20 from penetration by insects such as ants, termites, or similar.

[0051] In the composite wall structure, the composite sheathing layer 48 of 5/16 inch MgO board is punctured with the mechanical fasteners 50. In contrast, however, the waterproof insulating layer 52 and outer composite layer 54 of 5/16 inch MgO board are mounted without penetration of either layer by using a polyurethane structural adhesive. The adhesive provides a dual benefit of being both an adhesive and a sealant. The sealant feature, however, is optional to the wall performance. Alternatively, foam can be poured or foamed in-place between the two MgO board layers, which upon expansion of the foam eliminates the need for the adhesive.

[0052] A method of manufacturing the composite wall assembly 20 includes constructing a stud frame 22 using studs 24 and end members 32, 34 such as C-channels or similar as described above. Next, the inner, sheathing layer 48 of composite material is anchored to the stud frame 22, such as by driving fasteners 50 through the sheathing layer of composite material into the studs 24. The waterproof insulating layer 52 is then adhered to the surface of the sheathing layer 48 opposite the studs 24. The waterproof insulating layer 52 is therefore not punctured, and hence advantageously covers over and seals the fastener holes through the composite sheathing layer 48. The outer layer 54 of composite material is then adhered to the waterproof insulating layer 52 to protect the waterproof insulating layer from damage. The outer composite layer 54 also is not punctured, maintaining a waterproof and thermal barrier on the outside of the wall assembly 20.

[0053] Turning to FIGS. 5 through 7, the composite wall assembly 20 is designed to be prefabricated in sections (i.e., individual units) in a factory and assembled on site by connecting the wall sections with mechanical fasteners 56, adhesive/sealants, or any combination of fastening systems that is appropriate for the load requirements of a structural wall formed by the wall assembly sections. For example, by fas-
ttening together composite wall sections through the steel studs 24 of the assemblies 20 and utilizing adhesive/sealant between adjacent edges of the composite layers of polystyrene foam (waterproof insulating layer 52) and MgO board (outer composite layer 54), the integrity of the composite layers is not breached. A shim 58 may be placed between the adjacent studs 24 of two wall assembly sections. Further, an adhesive/sealant may be coated on the outer face of the outer composite layer 54 of the wall assembly 20 and may span across the seam between the two wall sections. For example, the adhesive/sealant may be a combination of fiberglass reinforced tape 60 and cementitious compound 62 such as MgO cement. This arrangement provides the composite wall with excellent waterproofing and thermal insulating properties.

[0054] Each individual section (unit) of the composite wall assembly 20 in accordance with the invention may form a modular component of a composite wall system 64. The composite wall system 64 includes a plurality of modular composite wall sections that are each defined by the structure of the composite wall assembly 20 as described above. The modular wall sections may be manufactured in a variety of lengths, such as but not limited to ten foot sections, twenty foot sections, thirty foot sections, forty foot sections, and the like. The modular wall sections may also be manufactured in a variety of heights, such as but not limited to eight foot tall sections, ten foot tall sections, and the like. Furthermore, certain modular wall sections may be manufactured with standard openings for doors and/or windows for use in constructing above grade building frames. Alternatively, some wall sections may be custom manufactured for unique/custom disposition of the door and/or window openings.

[0055] The composite wall system 64 may also include a variety of prefabricated connector components 120, 220 that can be used to connect two or more wall sections together in various configurations. For example, the connector components may include 90° elbows connectors, T-shaped connectors, Z-shaped connectors, and other similarly shaped connectors. Each connector component 120, 220 has a structure similar to the wall assembly 20 described above, including a frame having studs and end members, an inner sheathing layer of composite material, a waterproof insulating layer, and an outer layer of composite material.

[0056] The use of prefabricated connectors (e.g., 120, 220) allows for the edges of two composite wall assembly sections 20 to be connected at a corner or other angled junction of walls without puncturing the outer layers of the wall, thereby maintaining the waterproof seal provided by the outer layers of the wall assembly structure. In one embodiment, a sealant adhesive is placed between the wall sections 20 and the edges of a prefabricated connector (e.g., 120, 220), and the wall sections are thereby adhecred to the connector. Additionally, on the inside of the wall, the studs of the wall sections and the connector may be fastened together by mechanical fasteners such as bolts, screws, nails or similar. The seams between the wall sections and the connector are sealed by the adhesive to maintain a continuous waterproof barrier on the outside of the wall. Similarly, two wall sections may be connected together end-to-end in a generally straight line. A sealant adhesive seals the seams between the two wall sections, and adjacent studs of the two wall sections also may be fastened together.

[0057] As shown in FIG. 6, an example of a connector component 120 includes a frame 122 having studs 124 and end members (not shown), a sheathing layer 148 of composite material mounted on the studs 124 by fasteners 150, a waterproof insulating layer 152 adhered to the sheathing layer 148, and an outer layer 154 of composite material adhered to the waterproof insulating layer 152. In contrast to the wall assembly 20, some of the studs 124 of the frame 122 of the connector component 120 are disposed adjacent each other rather than spaced from each other.

[0058] As shown in FIG. 7, another example of a connector component 220 (in this case a corner connector) includes a frame 222 having studs 224 and end members (not shown), a sheathing layer 248 of composite material mounted on the studs 224 by fasteners 250, a waterproof insulating layer 252 adhered to the sheathing layer 248, and an outer layer 254 of composite material adhered to the waterproof insulating layer 252. In contrast to the wall assembly 20, some of the studs 224 of the frame 222 of the connector component 220 are disposed adjacent each other rather than spaced from each other.

[0059] Turning to FIGS. 8 through 10, in one application, the composite wall system 64 may be used to form the basement walls of a dwelling or similar building structure. The present composite wall's construction of structural capacity and waterproofing and thermal insulating properties make it an ideal design for use in a foundation system. The present composite wall system 64 is an improvement over conventional masonry foundations, because conventional masonry foundations are poor insulators, are not waterproof, and will always, over time, crack and leak water.

[0060] An engineered footing and drainage system 66 for supporting the composite wall on a lower end is installed within an excavation that is dug below ground level. The footing 68 of the footing and drainage system 66 may be a concrete footing that is poured and leveled prior to erecting the basement wall. The footing 68 may be leveled to an exacting tolerance, such as within 1/8" or similar. Further, the concrete footing 68 may be reinforced with metal rebar 70 to provide for increased resistance to ground movement that may be caused by settling of the structure erected on the footing.

[0061] In one embodiment, the footing 68 may be made by setting up permanent pre-manufactured footing forms 72 about the floor of the excavation. Since the footing forms 72 are manufactured, there are few to no variations from one form to another. This makes the process of leveling the footing 68 much easier and results in a precisely level footing when concrete is poured into the forms 72. In contrast, when wood is used as the material for the footing forms, natural warps and other inconsistencies in the wood make leveling the footing difficult. Further, the manufactured footing forms 72 are left in place after the concrete footing 68 is poured, eliminating the step of removing the forms that is customary when wood footing forms are used, thereby saving time. Once the concrete footing 68 has been installed within the footing forms 72, a basement floor 74 may be installed (e.g., by pouring concrete) within the area defined by the footing forms.

[0062] The footing forms 72 also include an integral drainage system. For example, the footing forms 72 may include an internal conduit 76 and openings 78 along an outer side to allow for communication of fluid to and from the internal conduit to the area (e.g., ground) outside of the footing 68. The footing forms 72 provide drainage on both the interior and exterior portions of the footing 68. A drain pipe (not shown) may also be connected to the outer side of the footing forms 72 to allow for flow of water from the internal conduit 76 to an area away from the footing 68. Further, a drain pipe
(not shown) may connect an outer footing form 72 with an inner footing form 72 to allow for flow of water from the conduit 76 of the outer form to the conduit 76 of the inner form. The drainage system thereby aids in the removal of water from the area inside the footing 68 (i.e., underneath the basement floor 74) and the area surrounding the outer periphery of the footing. Even more, the internal conduit 76 may be used to pipe radon gas from the ground around the footing 68 to a location away from the footing and any structure built on the footing. For example, after the composite wall system 64 is erected on the footing 68, a pipe for radon gas may be connected to a radon gas outlet in the footing form 72 and positioned generally vertically within the basement wall. Hence, the pipe is conveniently hidden from view. Alternatively, the radon gas piping may extend upwardly adjacent to the basement wall. After a dwelling or similar building is constructed above the basement wall, this pipeline may extend through the roof of the dwelling to exhaust the radon gas into the atmosphere above the dwelling. One suitable material for the footing forms is Form-A-Drain™ brand footing forms sold by CertainTeed Corporation.

Optionally, two footing forms 72 may be stacked one on top of the other to form a two-tiered internal conduit system. The conduit 76 in the upper of the two footing forms 72 is used to channel radon gas and the conduit 76 in the lower of the two footing forms 72 is used to channel ground water. This is due to the fact that radon gas generally rises while ground water generally seeps downward through the ground. In this embodiment, the footing 68 will have a depth that is twice as large in comparison to an embodiment in which only one layer of footing forms 72 is used.

A waterproof membrane material 80 such as a bituminous membrane or similar may be disposed between the footing 68 and composite wall 20 that is erected on the footing. For example, the membrane material 80 may be sandwiched between the footing 68 and the C-channel (end member 32) of the frame 22 of the composite wall 20. The membrane material 80 prevents moisture that rises through the concrete footing 68 from seeping into the composite wall 20 structure, especially preventing moisture from reaching the steel frame 22. The flexible waterproof membrane 80 also acts as an electrical insulator between the steel frame 22 and the concrete footing 68 helping to prevent any corrosion by galvanic reactions of dissimilar metals.

The composite wall system 64 is anchored to the footing 68 using galvanized steel anchor bolts 82 or similar that are threaded into the concrete footing 68. The galvanized anchor bolts 82 are placed on 16 inch centers except at the end of each wall section where two anchor bolts are equally spaced in a side by side configuration (for example, see FIG. 10). A galvanized steel washer 84 is placed under the head of the anchor bolt 82. A phenolic washer 86 is placed under the steel washer 84 to act as an electrical insulator to help prevent any corrosion due to galvanic reactions of dissimilar metals. A pressure-treated wood sill 88 is applied to the top of the wall 20. The sill 88 is used to tie the tops of wall sections together. The sill 88 is anchored through the C-channel (end member 34) at the top of the wall 20 using self-tapping, self-drilling wood-to-metal screws 90 or similar.

The sections of the composite wall 20 are tied together using a combination of shims 58 between the steel studs 24 of each wall section along with adhesive/sealant between the waterproof insulating layer 52 and MgO composite layers 48, 54 as described above. Self-drilling screws are used to anchor the steel studs 24 at the end of each wall section. A combination of fiberglass reinforced tape 60 and cementitious compound 62 such as MgO cement is used to seal the outer layer between the wall sections.

Optionally, a combination of a flexible waterproof membrane and adhesive may be used on the exterior joints between the wall sections and at the exterior base of the wall where the wall 20 and footing 68 meet.

After erecting the composite wall system 64 on the footing 68, a basement floor 74, such as a concrete floor, may also be installed (e.g., by pouring concrete). Further, earth may be backfilled into the open space between the basement wall and the excavation. The outer layer 54 of composite material protects the wall from damage by the backfill 92. The structure of the composite wall 20 advantageously protects and insulates the wall from the footing 68 up to the sill 88.

The above described composite wall system 64 provides for a foundation that is fully insulated and waterproofed from the footing 68 to the sill 88 on the exterior of the foundation. It also has an engineered footing system 66 that provides the excellent support and drainage for the walls. The entire system also has the capability to flex with ground movement resulting from the building settling. In addition, the interior of the foundation is studded and ready to finish.

Although the invention has been described by reference to specific embodiments, it should be understood that numerous changes may be made within the spirit and scope of the inventive concepts described. Accordingly, it is intended that the invention not be limited to the described embodiments, but that it have the full scope defined by the language of the following claims.

What is claimed is:
1. A composite wall assembly comprising:
a frame;
a sheathing layer of composite material mounted on said frame;
at least one waterproof insulating layer attached to said sheathing layer; and
an outer layer of composite material attached to said waterproof insulating layer, wherein at least said outer layer of composite material is devoid of any puncture holes through said outer layer.
2. The composite wall assembly of claim 1, wherein said sheathing layer is a magnesium oxide composite board material.
3. The composite wall assembly of claim 1, wherein said waterproof insulating layer is a foam extruded polystyrene.
4. The composite wall assembly of claim 1, wherein said outer layer is a magnesium oxide composite board material.
5. The composite wall assembly of claim 1, wherein said sheathing layer is mounted on said frame by at least one of a plurality of mechanical fasteners and an adhesive.
6. The composite wall assembly of claim 1, wherein said waterproof insulating layer and said outer layer are attached without forming puncture holes through said layers.
7. The composite wall assembly of claim 1, wherein said frame includes a plurality of spaced studs disposed between first and second end members.
8. The composite wall assembly of claim 7, wherein said studs are generally C-shaped and said end members are C-channels.
9. The composite wall assembly of claim 1, wherein at least said outer layer of composite material is devoid of any mechanical fasteners which puncture through said outer layer.

10. The composite wall assembly of claim 9, wherein the waterproof insulating layer is devoid of any mechanical fasteners which puncture through said outer layer.

11. A composite wall system comprising:
   a first composite wall section including:
   a first frame;
   a first sheathing layer of composite material mounted on said first frame;
   a first waterproof insulating layer adhered to said first sheathing layer; and
   a first outer layer of composite material adhered to said first waterproof insulating layer opposite said first sheathing layer, said first outer layer of composite material being devoid of any puncture holes through said first outer layer;

   a second composite wall section including:
   a second frame;
   a second sheathing layer of composite material mounted on said second frame;
   a second waterproof insulating layer adhered to said second sheathing layer; and
   a second outer layer of composite material adhered to said second waterproof insulating layer opposite said second sheathing layer, said second outer layer of composite material being devoid of any puncture holes through said second outer layer,

   wherein said first composite wall section is connected to said second composite wall section through said first and second frames.

12. The composite wall system of claim 11, wherein said first and second frames include a plurality of spaced studs; and

   said first composite wall section is connected to said second composite wall section by mechanical fasteners extending through one said stud of said first frame and one adjacent stud of said second frame.

13. The composite wall system of claim 11, wherein a seam between said first and second composite wall sections is sealed with a sealant adhesive.

14. The composite wall system of claim 11, including a connector component disposed between and connected to said first and second composite wall sections, wherein said connector component includes:
   a connector frame;
   a connector sheathing layer of composite material mounted on said connector frame;
   a connector waterproof insulating layer adhered to said connector sheathing layer; and
   a connector outer layer of composite material adhered to said connector waterproof insulating layer opposite said connector sheathing layer.

15. The composite wall system of claim 14, wherein said connector component is one of a 90° elbow connector, a T-shaped connector, and a Z-shaped connector.

16. The composite wall system of claim 14, wherein said first frame, said second frame, and said connector frame each include a plurality of spaced studs;

   said first composite wall section is connected to said connector component by mechanical fasteners extending through one said stud of said first frame and one adjacent stud of said connector frame; and
   said second composite wall section is connected to said connector component by mechanical fasteners extending through one said stud of said second frame and one adjacent stud of said connector frame.

17. The composite wall system of claim 14, wherein a seam between said first composite wall section and said connector component is sealed with a sealant adhesive, and a seam between said second composite wall section and said connector component is sealed with a sealant adhesive.

18. The composite wall system of claim 11, wherein said first and second composite wall sections are erected on a concrete footing.

19. The composite wall system of claim 18, including a waterproof membrane disposed between said footing and said first and second composite wall sections.

20. The composite wall system of claim 18, wherein said first and second composite wall sections form walls of a basement.

21. A method of assembling a composite wall comprising the steps of:

   constructing a frame including a plurality of spaced studs disposed between first and second end members;
   mounting a sheathing layer of composite material on said frame with mechanical fasteners extending through said sheathing layer and said studs;
   adhering at least one waterproof insulating layer to said sheathing layer without puncturing said waterproof insulating layer; and
   adhering an outer layer of composite material to said waterproof insulating layer opposite said sheathing layer without puncturing said outer layer.

22. The method of claim 21, wherein said sheathing layer and said outer layer are made of a magnesium oxide composite board material.

23. A composite wall assembly comprising:
   a frame;
   a sheathing layer of composite material mounted on said frame;

   at least one waterproof insulating layer attached to said sheathing layer; and
   an outer layer of composite material attached to said waterproof insulating layer opposite said sheathing layer,

   wherein at least said outer layer of composite material is devoid of any mechanical fasteners which puncture through said outer layer.

24. The composite wall assembly of claim 23, wherein the waterproof insulating layer is devoid of any mechanical fasteners which puncture through said outer layer.