A method for forming integrally insulated concrete sandwich walls or wall components is disclosed. The walls are fabricated by casting the walls vertically and pumping the concrete from the bottom of the form or from sides near the base. Walls fabricated thus can be used in commercial, industrial, residential, and agricultural buildings. These walls can be cast on-site or in a manufacturing plant.
METHOD OF FABRICATING INTEGRALLY INSULATED CONCRETE WALL OR WALL COMPONENTS


BACKGROUND OF THE INVENTION

[0002] The invention generally relates to method of fabricating integrally insulated concrete walls or wall components. This invention is an improvement of existing methods of fabricating the integrally insulated concrete wall or wall components.

[0003] Integrally insulated concrete walls (also known as sandwich walls) are well known in the art and offer a number of advantages to the residential, commercial, institutional and agricultural industry building construction. These walls are typically cast at a manufacturing plant or on-site. The walls can be cast horizontally or vertically and when cast vertically; the concrete is placed from top of the forms.

[0004] Integrally insulated concrete walls contain two outer layers or wythes of concrete sandwiching rigid insulation board. Connectors are used to tie the outer layer concrete through the inner layer concrete through the insulation. The connectors can be metallic or non-metallic. Typically, the rigid insulation board is a type of extruded polystyrene, expanded polystyrene, or polyisocyanurate or other rigid board insulation. Many types of connectors, both metallic and non-metallic, are available in the market.

[0005] One of the current fabrication techniques for plant cast wall panels is casting the panels horizontally in a casting bed. This method requires a large floor area in the plant and requires a secondary finishing operation to the top surface of the concrete. In the other method of plant cast panels, wall panels are cast vertically but the concrete is placed from the top of the form. In this method concrete is dropped from the top and requires substantial vibration to achieve a smooth finish to exterior surfaces of the concrete wythes. The disadvantage of dropping concrete from the top is that concrete tends to segregate and hence the drop height is often limited to eight feet which limits the wall height that can be poured. Dropping concrete also leads to an increase in entrained air. Additionally, placement of concrete can be difficult if not impossible when the exterior wythe thickness is less than three inches, a limitation which limits the minimum thickness of walls that can be formed. With increased thickness of the wythes, the weight of the wall component is more, this limiting the size of the wall component that can be transported to a remote location and increasing the cost of such shipping.

[0006] In the horizontal site cast application, also known as tilt-up, the panels are cast horizontally on the floor slab of the building. Typically in this method, the fascia wythe is placed first and then the insulation and connectors are placed on top of the fascia wythe while the concrete is still plastic. The structural wythe reinforcing is then placed on top of the insulation after about 24 hours or after the fascia concrete has hardened sufficiently. Finally, the structural wythe concrete is placed and finished.

[0007] In the vertical site cast application, the walls are formed in place with insulation and reinforcing and then the concrete is placed from the top of the form into the form with or without a tremie. When the concrete is dropped from the top of the form, the components of the concrete tend to segregate and also the concrete tends to entrain air. The concrete must be vibrated to consolidate the concrete and for concrete to flow into the large pockets typically left due to the restriction to concrete flow between the formwork due to the presence of reinforcing and doors and window openings. However, this vibration process will cause the entrained air to travel towards the formwork and cause for surface blemishes.

[0008] In the present invention, the method of fabrication is improved by setting up the vertical forms in a manufacturing plant or on-site and introducing the concrete from the base or near the base in both wythes simultaneously.

[0009] The primary objective of the present invention is an improved method of fabrication of integrally insulated concrete wall that results in wall components that may have different surface finishes on the two outwardly facing surfaces.

[0010] Another objective of the present invention is the ability of setting up the formwork anywhere with little site preparation since the formwork can be self contained with adjustable sides, base and adjustable bulkhead.

[0011] Yet another objective of the present invention is to pump concrete from the bottom or near the base. This method eliminates the need for vibrating concrete.

[0012] Another objective of the present invention is to be able to construct vertical cast sandwich walls with thinner interior and/or exterior wythes.

[0013] A further objective of this invention is its ability to use different colored concrete or concrete with different properties in the fascia wythe and the structural wythe simultaneously.

[0014] Yet another objective is to construct taller single pour walls without segregation of concrete.

[0015] Yet another objective is to eliminate or limit insulation displacement during concrete placement.

[0016] Still another objective is to use a vacuum and/or pressurized air, fluid or both to assist in placing the concrete in the form.

[0017] These and other objectives become apparent from the following description of the invention.

SUMMARY OF INVENTION

[0018] In the present invention of fabricating integrally insulated concrete wall, the wall panels are fabricated by casting the walls or wall components vertically and pumping the concrete from the bottom of the form or from sides near the base. Walls and wall components fabricated thus can be used in commercial, industrial, residential, and agricultural buildings. These panels can be cast on-site or in a manufacturing plant. The formwork for the panels contains a fixed vertical form and a moveable base form. The bulkheads are adjustable to accommodate various thickness of wall and various lengths of the wall. Once the height and length of the wall component is set, the reinforcing, insulation and the connectors are placed in the form. The end form is then placed to close the form. A ball valve, gate valve, plunger valve, or other similar valve system is used on or near the bottom of the form to introduce concrete in both wythes simultaneously. The wall panel can be one single panel or it can be multiple panels poured parallel to each other or it can be a multiple sided module.

BRIEF DESCRIPTION OF THE DRAWINGS

[0019] FIG. 1 is a perspective view showing the formwork and panel with preferred non-metallic connectors connecting the two wythes of concrete.
FIG. 2 is a cross sectional view of an alternative embodiment of the present invention wherein the formwork is provided with airtight seals and placement of the concrete in the form is assisted by a vacuum that communicates with the top of the form.

FIG. 3 is a cross sectional view of an alternative embodiment of the present invention wherein a concrete hopper is charged with a pressurized air, fluid or both to force the plastic concrete into the form without the need for a concrete pump.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Illustrated in FIG. 1, generally at 2 is the preferred embodiment of metal fixed vertical form for forming concrete sandwich wall components, including concrete sandwich walls. This form can also be made of other materials. Movable base 3 is an adjustable base so that different height and thickness walls can be constructed. This base 3 preferably includes a leveling mechanism to keep the base 3 level even if the ground is not level on-site. The base 3 contains one or more openings 4 with ball valve, a gate valve or a plunger valve or similar valve (not shown) to pump concrete from the bottom. Adjustable bulkheads 5 are set on top of the movable base 3 with help of magnets or other means to keep it in place. With adjustable and interchangeable bulkheads 5, the length and thickness of the wall can be adjusted. After the bulkheads 5 are setup for the correct wall length and thickness, the reinforcing 9 for the wythe adjacent to the fixed form is placed. Then insulation 6 and the connectors 7 are placed in the form 2. In the preferred embodiment, the insulation 6 is extruded polystyrene board insulation with fiber composite connectors 7. After placing the insulation 6, the reinforcing 9 for the other wythe is placed and the movable form 10 is placed at the correct location. In the preferred embodiment, another set of one or more openings 4 with a ball valve, a gate valve or a plunger valve or similar valve are located in the base closer to the movable form 10. The whole assembly may be braced with braces 11 on both sides of the form 2.

Concrete is then pumped from the bottom through opening 4 either with one pump or more pumps. When different colored or different properties concrete are used for two wythes, each type of concrete is pumped with different pump. The rate of pumping concrete is adjusted such that the concrete in both wythes fills up to substantially the same height simultaneously. In the alternate method of pumping, the concrete can be pumped from the sides near the base through the openings 12 on either or both sides or from the end of the form 2. The pumping is continued until the concrete raises to the top of the form 2 or to the required height of the wall. If needed, lifting devices (not shown) are placed near the top of the forms using magnets or tied to the reinforcing 9. When the concrete has hardened sufficiently, the forms are removed after the lifting lines are attached to the lifting hardware which is placed in the concrete during the fabrication process.

The multiple openings 4 allow plastic concrete to enter the form from both sides of the insulation 6. If desired, concrete can be provided from different sources to the different wythes on opposite sides of the insulation 6. Accordingly, different types of concrete can be used for the different wythes simultaneously. For example, one of the wythes may be formed of a concrete that is a different color that the concrete that forms the other wythe. In another example, concrete of different physical properties can be used to form the different wythes as may be advantageous if one of the wythes is an outside wall exposed to the elements and the other is a protected inside wall.

Haring openings 4 and 12 are particularly applicable if the form 2 is divided into regions that are not common at the bottom of the form 2, as is the case if a door opening was being formed. Without multiple openings 4 and 12, the plastic concrete would need to fill up the form on one side of the door opening until it exceeded the height of the door opening and then would pour down the height of the door opening into the other chamber of the form 2.

Some of the alternate embodiments are to cast another wall on the other side of fixed form, which becomes the common form for both walls or wall components, to add another section of wall, perpendicular or at an angle to one or both ends of the wall. Another embodiment is to fabricate more than two walls or wall components side by side.

An advantage of the present invention is that introducing plastic concrete into the bottom of the form 2, rather than pouring it in from the top as is done in the prior art, assists in forcing air out of the plastic concrete in the form 2, thus reducing the need for vibration or other methods for removing air and reducing the occurrence of voids in the formed concrete due to air pockets. Introducing the plastic concrete into the bottom of the form 2 is also advantageous in that it reduces the hydraulic pressure that is imposed on the form 2 and insulation 6 by the plastic concrete compared to the conventional method wherein the plastic concrete is poured into the top of the form. Filling of the two sides of the form at the same time reduces the differential in pressure on the integrally located insulation and reduces the need for reinforcement of the insulation with the result that a greater variety of connectors can be used.

In an alternative embodiment, a form 16 is constructed so that it is air tight, including, for example, a top cover 18 (FIG. 2). The interior of the form 16 is placed in communication with a vacuum chamber 20 or other source of a vacuum. Plastic concrete is provided in a hopper 22 that is connected to a pair of openings 24 and 26 on either side of the form 16. Valves 28 and 30 control the flow of plastic concrete 36 into the form 16. In operation, once the form 16 has been constructed and sealed, concrete is placed in the form 16 by opening of the valves 28 and 30 and connecting the vacuum source. The vacuum assists in drawing the concrete from the concrete hopper 22 into the form 16 and also assists in the removal of air from the form 16.

In another alternative embodiment, an alternative concrete hopper 32, 38 is provided with a bladder 40 or similar system for applying a positive pressure to the concrete to assist in forcing the plastic concrete 36 from the hopper 32 into the form 44 (FIG. 3). Pressurized fluid 34, such as air, another gas, or a liquid, is introduced above the bladder 40 through a supply line 42. In this way, pressurized concrete is provided without the need for expensive and high maintenance concrete pumps. It is of course possible to combine the systems of FIG. 2 and FIG. 3 wherein both a vacuum is created on the top of the form and pressurized fluid assists in introducing the plastic concrete into the form. If the plastic concrete has sufficiently low viscosity, such as some so called self-consolidating concretes, gravity alone would be sufficient to force the plastic concrete into the form.

The foregoing description and drawings comprise illustrative embodiments of the present inventions. The fore-
going embodiments and the methods described herein may vary based on the ability, experience, and preference of those skilled in the art. Merely listing the steps of the method in a certain order does not constitute any limitation on the order of the steps of the method. The foregoing description and drawings merely explain and illustrate the invention, and the invention is not limited thereto, except insofar as the claims are so limited. Those skilled in the art who have the disclosure before them will be able to make modifications and variations therein without departing from the scope of the invention.

I claim:

1. A method of fabricating a section of an integrally insulated concrete sandwich wall component in a plant or on-site, comprising the steps of:
   (a) providing a form having a bottom panel, a pair of upright, opposing side panels and insulation supported between the side panels;
   (b) providing an opening in or near the bottom of the form; and
   (c) introducing plastic concrete into the form through the opening.

2. The method of claim 1, further comprising a second opening in or near the bottom of the form and introducing the plastic concrete into the form simultaneously through both openings.

3. The method of claim 2, wherein plastic concrete of a first type is introduced into the form through the first opening and plastic concrete of a second type is introduced into the form through the second opening.

4. The method of claim 3, wherein the first type of concrete is a different color than the second type of concrete.

5. The method of claim 3, wherein the first type of concrete has a different aggregate composition than the second type of concrete.

6. The method of claim 3, wherein the first type of concrete forms substantially against a first of the upright panels and the second type of concrete forms substantially against the second of the upright panels.

7. The method of claim 1, further comprising the step of sealing the form and producing a vacuum in the form to assist in introducing the concrete into the form.

8. The method of claim 1, wherein the plastic concrete is introduced from a pressurized hopper.

9. The method of claim 8, wherein the pressure is produced by a pressurized fluid.

10. The method of claim 1, wherein the two side panels have textures on their interior surfaces that are different from each other.

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