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(54) STRUCTURAL COMPOSITE PANEL, METHOD OF FABRICATION, AND CONSTRUCTION

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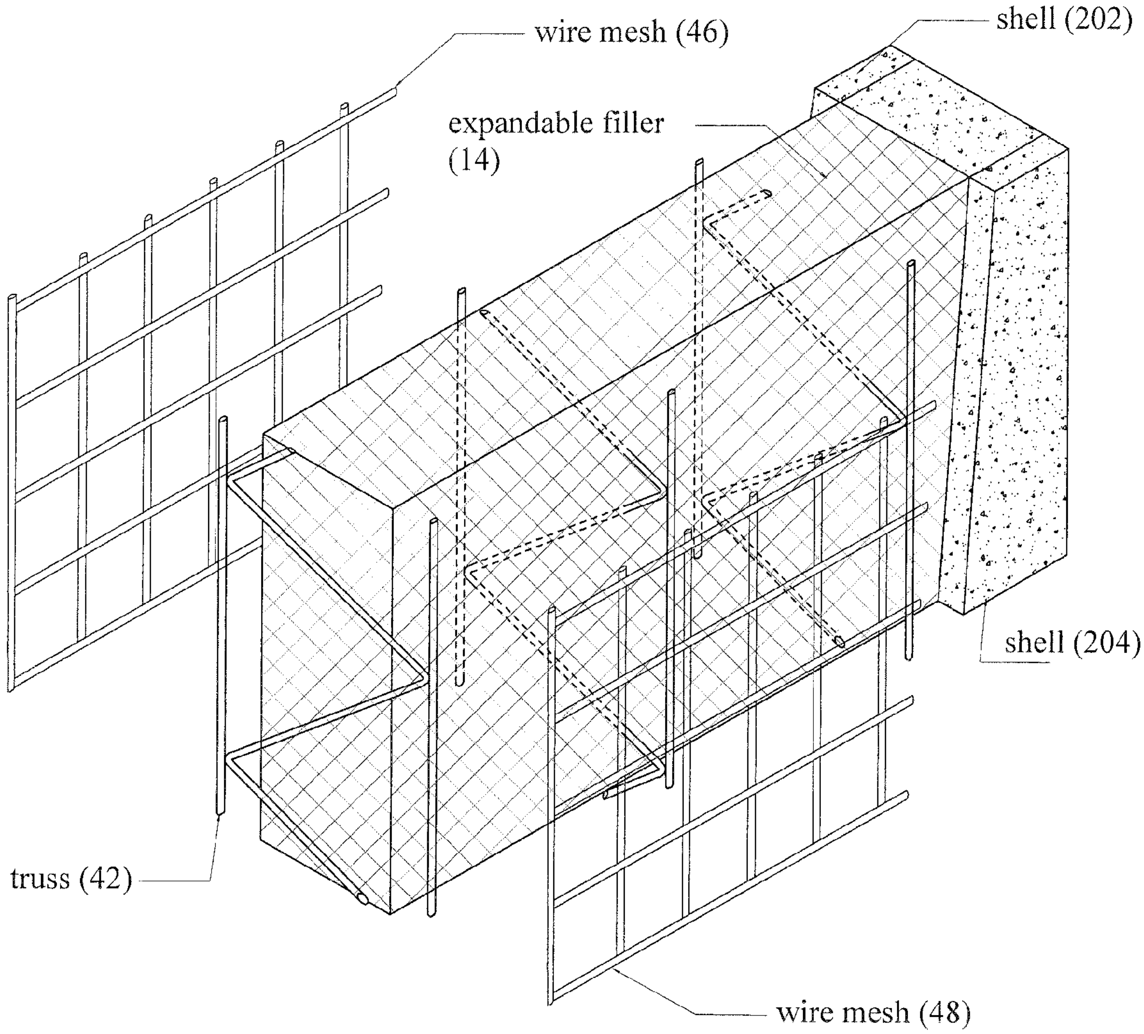
(57) **ABSTRACT**

A machine for fabricating a composite structural panel is provided that receives trusses vertically and feeds them into a foam spray chamber driven by first and second drive mechanisms. The drive mechanisms form the filler material and maintain the trusses in place while a cutting blade trims off excess foam.



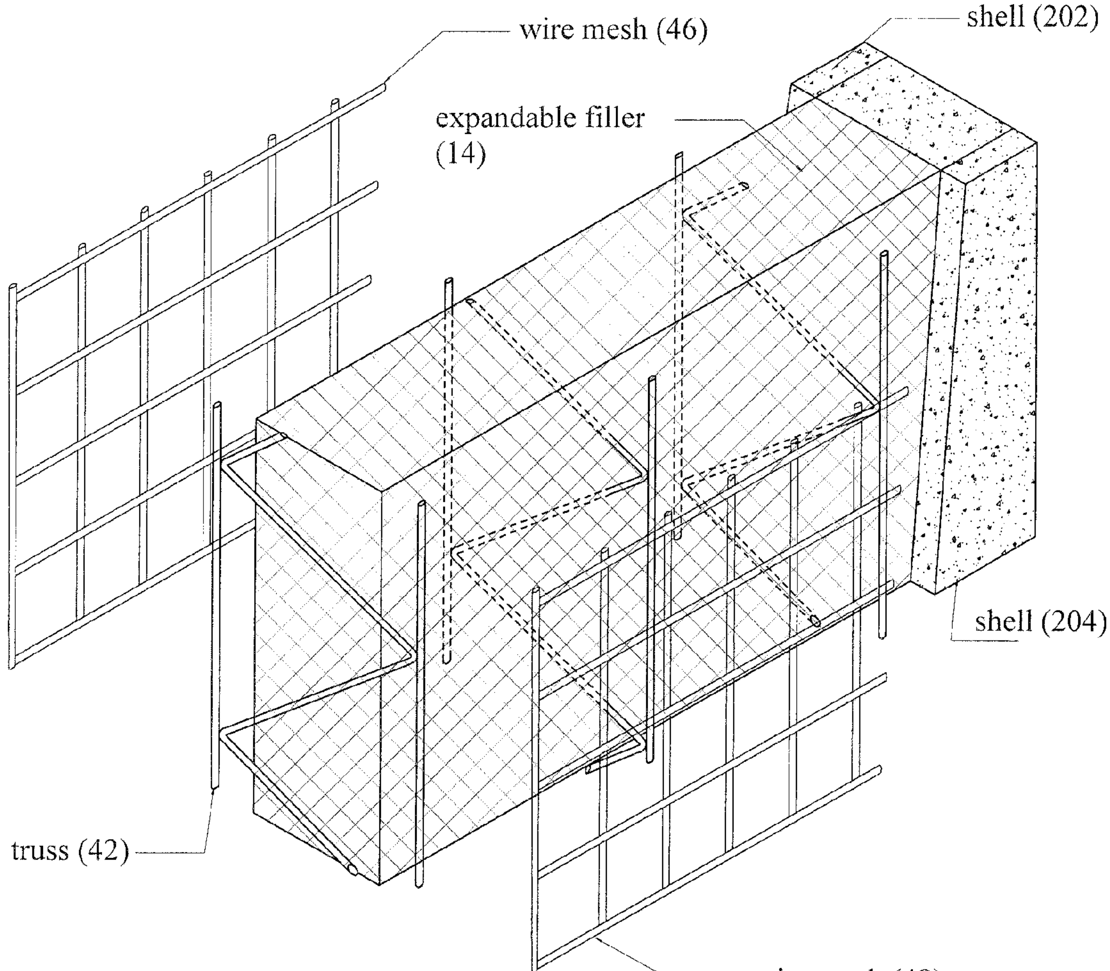

wire mesh (46)
shell (202)
expandable filler
(14)
shell (204)
truss (42)
wire mesh (48)

FIGURE 1 (a)

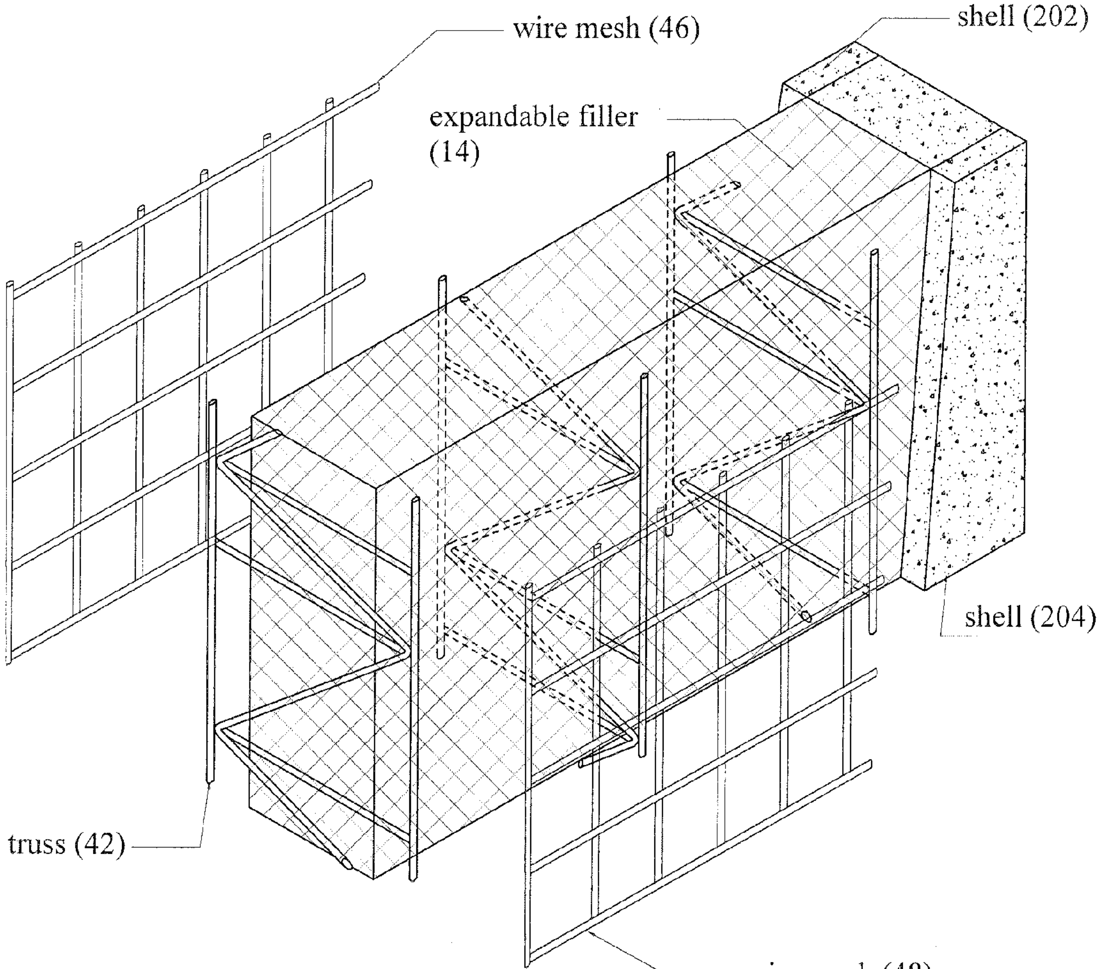

wire mesh (46)
shell (202)
expandable filler (14)
shell (204)
truss (42)
wire mesh (48)

FIGURE 1 (b)

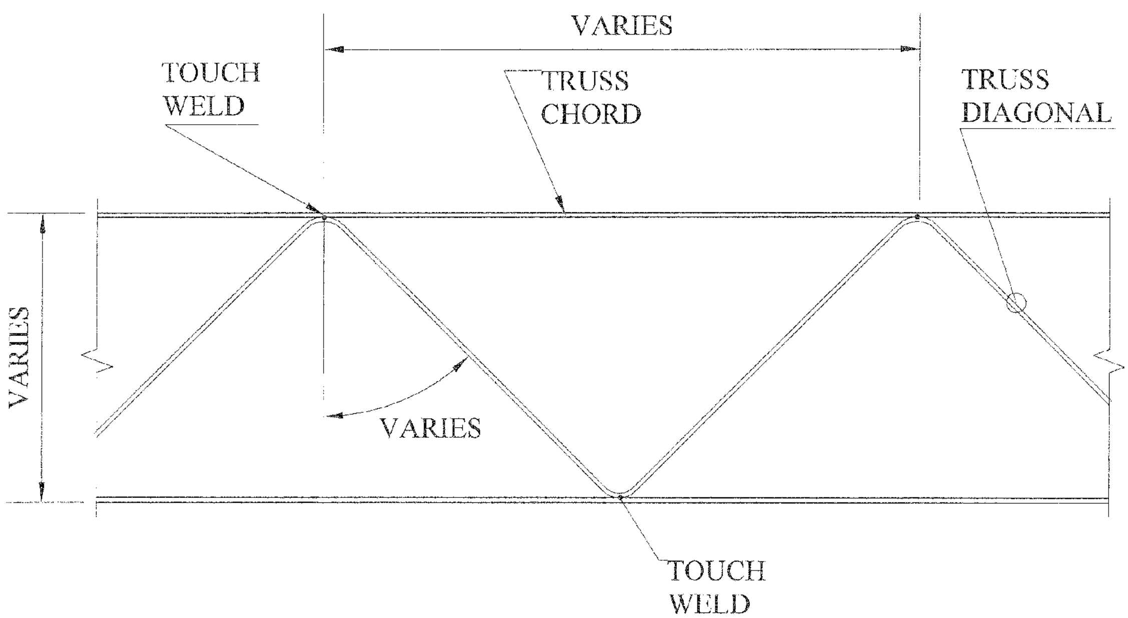

VARIES
TOUCH
WELD
TRUSS
CHORD
TRUSS
DIAGONAL
VARIES
VARIES
TOUCH
WELD

FIG. 2

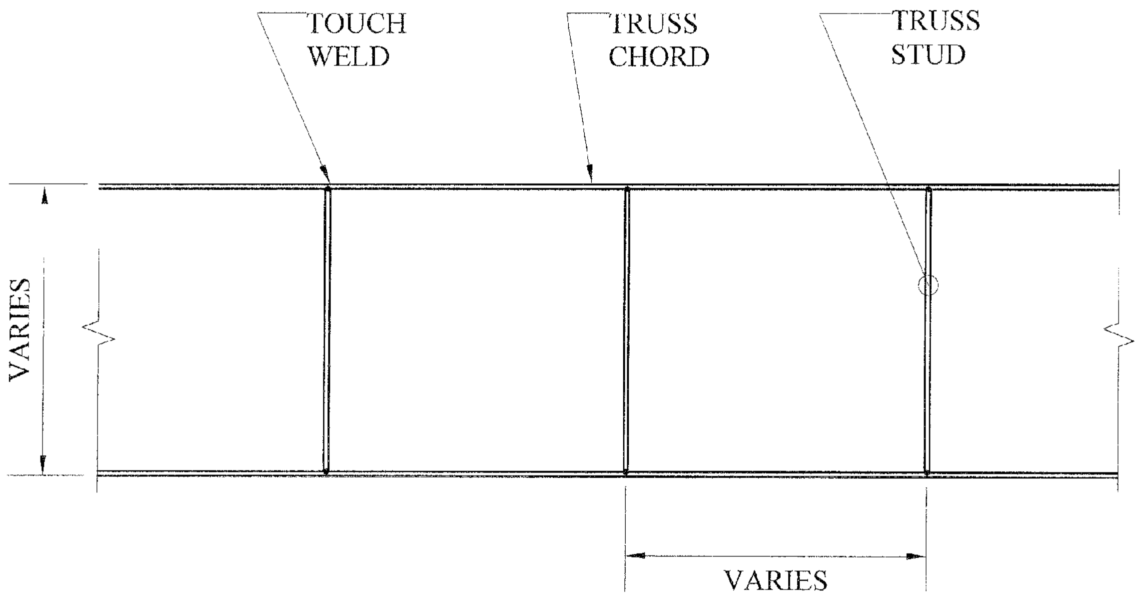


FIG. 3

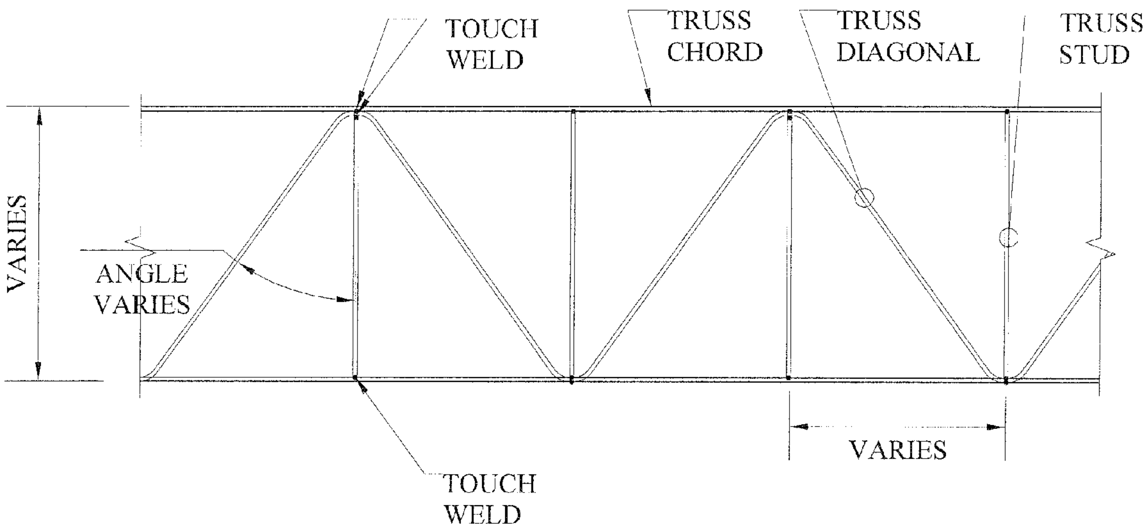

TOUCH
WELD
TRUSS
CHORD
TRUSS
DIAGONAL
TRUSS
STUD
VARIES
ANGLE
VARIES
VARIES
TOUCH
WELD

FIG. 4

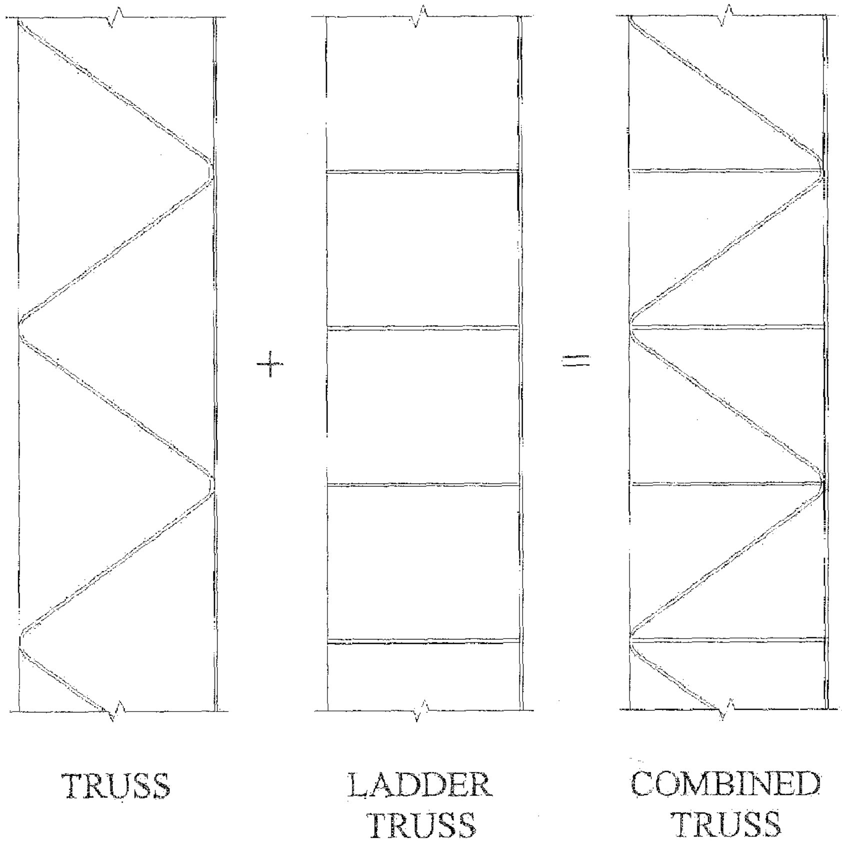

+
=
TRUSS
LADDER TRUSS
COMBINED TRUSS

FIG. 5

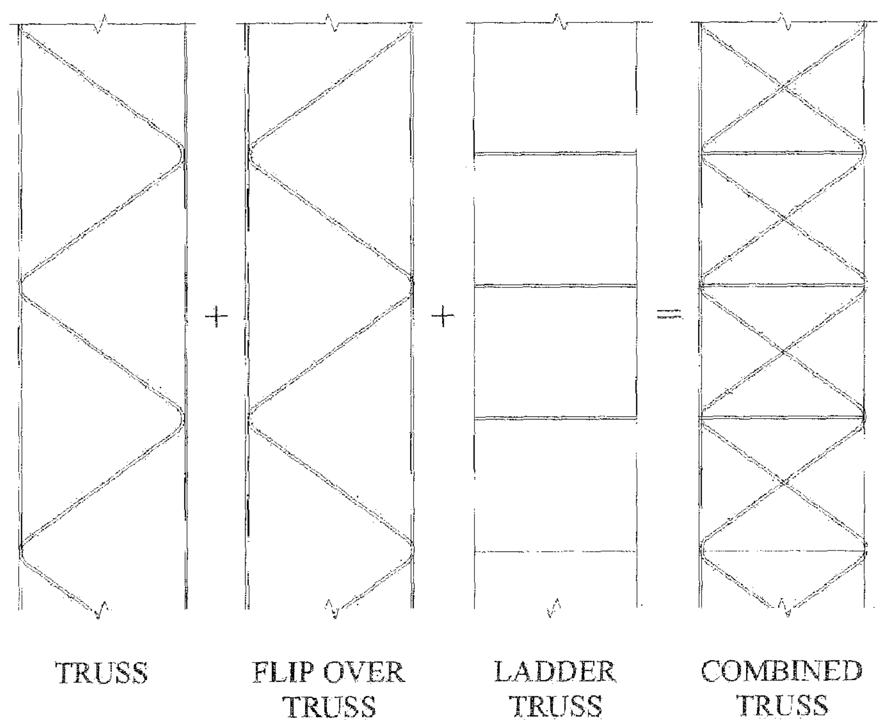

+
+
=
TRUSS
FLIP OVER TRUSS
LADDER TRUSS
COMBINED TRUSS

FIG. 6

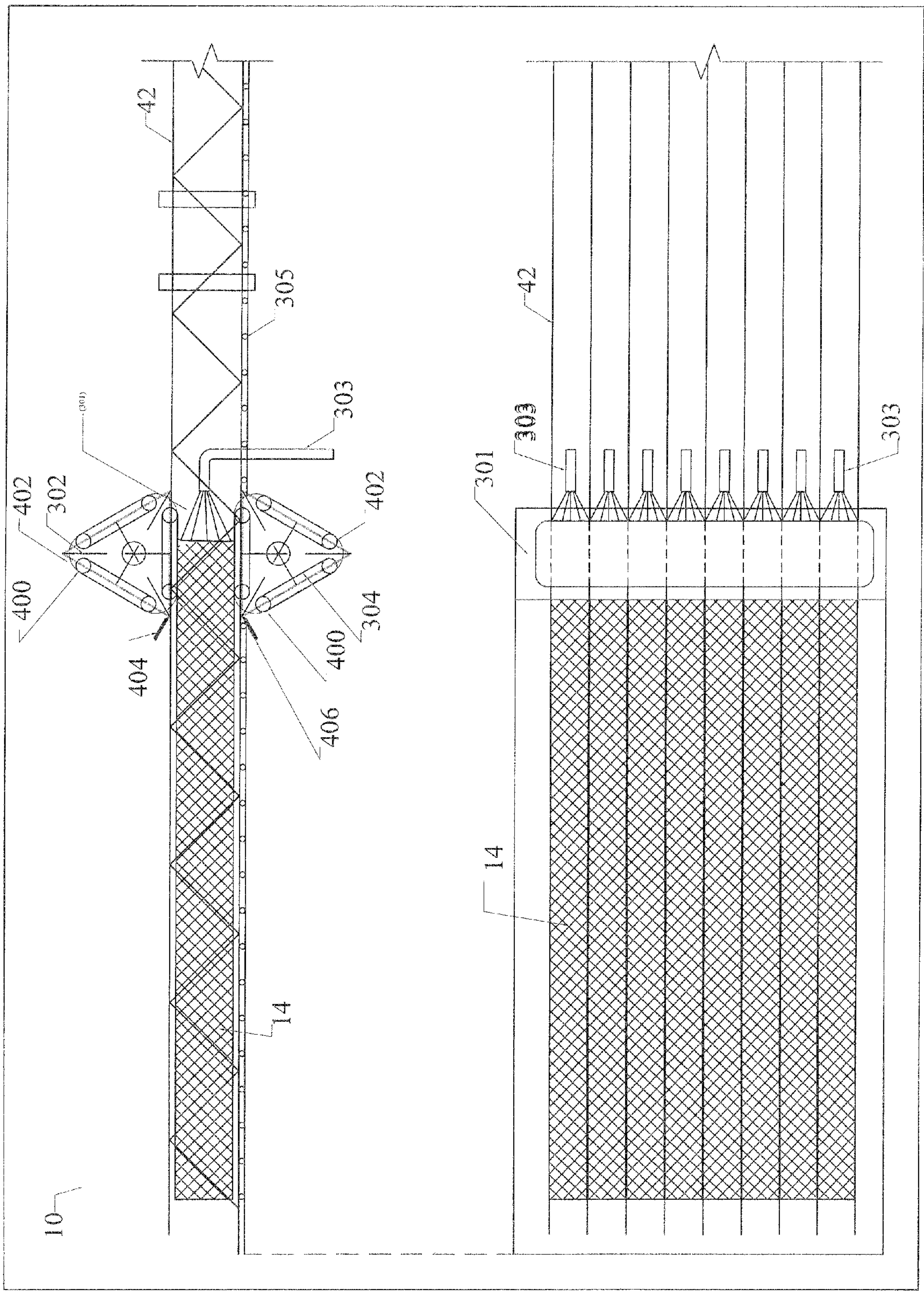


FIG. 7

STRUCTURAL COMPOSITE PANEL, METHOD OF FABRICATION, AND CONSTRUCTION

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application claims priority to provisional patent application No. 60/888,733, which is hereby incorporated by reference.

FIELD OF THE INVENTION

[0002] The present invention generally relates to the field of structural panels and more specifically to panel composition, manufacturing process, and installation and construction with those panels.

BACKGROUND OF THE INVENTION

[0003] Structural Concrete Insulating Panels (SCIP) are typically composed of two or more structural shells that are separated with an insulating material and connected via steel trusses. In a typical SCIP panel, the shells are fabricated from concrete, the insulating material is foam and the trusses are composed of wire. Such SCIPs are used in building homes and other structures by relatively unskilled laborers and are pre-fabricated and sent to the jobsite. SCIP panels are advantageous in that the same type of panel may be used to erect walls, floors, ceilings, and roofs by relatively unskilled laborers, provide good insulation, high sound-proofing, and may be produced with environmentally friendly materials. Disadvantageously, the cost of implementing SCIPs can become high due to costs associated with meeting building code requirements, fabrication and construction costs. Also, the methods used to fabricate SCIPs generally are such that require the usage of lathing members and wire mesh attachment to the panel in order to produce a product that is possible to transport to the jobsite. The present invention addresses those needs in the art.

[0004] One major component that increases SCIP cost is the rigid foam. For example, U.S. Pat. No. 6,718,712 discloses pre-fabricated structural panels and a method of fabrication, which utilizes commercially available panel components, and uses compression method of rigid foam blocks employing trusses in between of them. Also, lathing members are being used in order to provide proper spacing between the rigid foam blocks and the truss apexes; and wire-mesh is used at both surfaces of the panel and clipped to the truss apexes in order to provide compression of rigid foam blocks and make manufacturing of the panel possible.

[0005] Disadvantageously, the '712 patent uses methodology of fabrication that does not allow flexibility in using different type of fillers and thus is relatively inefficient and uneconomical for panel construction. Also, the suggested compression method does not allow proper alignment of rigid filler blocks and their proper location precisely in the middle of truss widths, which is required by design engineering principles of SCIP panels. Thus there is no sufficient quality of final product which is necessary for building safe and structurally sound structures.

[0006] Additionally, the existence of a gap between the rigid foam blocks creates a possibility for water penetration through the panel into the structure. Overall, the '712 patent and the consequent CIP US 2005/0284088 A1 fail to provide a sound method of manufacturing, installation and construction which will provide for a sufficient quality control and construction of the structures to comply with engineering design principles of those structures.

SUMMARY OF THE INVENTION

[0007] The present invention provides a machine for fabricating a composite structural panel having a plurality of trusses held together by foam. The machine includes an elongated generally flat conveyer system having a plurality of elongated cylindrical rollers positioned horizontally along the conveyer system for receiving trusses vertically positioned along the conveyer system in spaced-apart relation and allowing the trusses to traverse thereacross. The machine further includes first and second drive mechanisms each having at least one generally flat portion on a side thereof, the first drive mechanism having the at least one generally flat portion positioned coplanar to the conveyer system for engaging and feeding one side of the panel therethrough, the second drive mechanism being positioned in opposed relation to the first drive mechanism for engaging and feeding another side of the panel therethrough, the first and second drive mechanisms collectively defining a foam spray chamber therebetween. The machine also includes a plurality of spray nozzles positioned across the conveyer system in spaced-apart relation and pointed toward the foam spray chamber for forming foam between each side of the panel. The machine further includes first and second cutting blades being positioned adjacent a side portion of the first and second drive mechanisms respectively for trimming excess foam from the panel. There is also provided a method of fabricating such a panel using the above-identified machine. Advantageously, the present invention provides a different method of SCIP composition; qualitatively different fabrication method of SCIPs. More specifically, while it is understood that SCIPs are well known in the art and can be manufactured according to a variety of different ways, the current problem is that from an engineering perspective, there is no known methodology for its composition and fabrication that will be both cost effective and with high quality control. Moreover, the necessity of having certain components which otherwise would have been optional, in the panel manufacturing process, such as the wire mesh and lathing members, makes the SCIPs not cost effective. The present invention addresses that need by providing a novel method of SCIP composition and its fabrication methodology. The present invention provides the manufacturer with the ability to produce panels of any size and configuration so long as it meets the general category of SCIP. Additionally, current invention allows to make the usage of lathing members and wire mesh optional, independent of manufacturing process, and to be specified by the design engineer if needed.

[0008] Present invention suggests that instead of using separate blocks of rigid foam or alternative fillers, expandable environmentally clean foam or alternative expandable material is applied around the trusses during the fabrication process through the nozzles integrated in the manufacturing machine's chamber. The expansion and hardening time of such materials provide for continuous conveyer type of SCIP manufacturing. The usage of such technology will provide the following benefits—cutting the costs of using prefabricated expensive foam blocks or equivalent; exclusion of any lathing members from the panel; avoids the necessity to clip the wire mesh to the truss chords at all possible locations during the fabrication process; fabrication of panels of any length necessary for the structure by saw-cutting the continuous panels at the end of fabrication; fixed locations of trusses in the panel and in relation to both surfaces of the expanded foam or alternative expandable material; creation of solid and continuous filler from foam or alternative expandable material that avoids penetration of the water inside the structures; elimination of compression methodology and its adjustment during multi-truss usage; application of the wire mesh as an optional component in the panel in case the design engineer will decide to use it during the design; elimination of lathing members typical for all SCIPs; faster fabrication speed; cost-effectiveness of the end product.

BRIEF DESCRIPTION OF THE DRAWINGS

[0009] FIG. **1** is a perspective view of a SCIP having expanded foam or equivalent expandable filler material and the trusses embedded therein; FIG. **1** is presented in two versions FIG. **1**(*a*) and FIG. **1**(*b*) illustrating different truss combinations.

[0010] FIG. **2** is elevational view of a truss with zigzag wires;

[0011] FIG. **3** is elevational view of a ladder truss;

[0012] FIG. **4** is elevational view of a combined truss;

[0013] FIG. **5** is a view illustrating the combination of a ladder truss with a warren truss;

[0014] FIG. **6** is a view of a ladder truss combined with a first warren truss and an inverted second warren truss; and

[0015] FIG. **7** is a diagram of fabrication process showing the trusses moving in the spray chamber and application of the expandable foam or equivalent material in the chamber.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

[0016] Referring now to the drawings wherein the showings are for purposes of illustrating preferred embodiments of the present invention only, and not for purposes of limiting the same,

[0017] The first step in manufacturing a composite structural panel according to the present invention is selecting a structural panel per design engineers recommendation having at least two structural shells **202** and **204**, an expandable insulating material **14** therebetween, and a plurality of truss members **42** embedded therebetween before the expansion of insulating material. It is understood that an expandable insulating material or filler **14** may include expandable liquid foam, polystyrene insulation foam and other types of materials which both provide insulating properties and are compatible with the system of the present invention. For example, it is contemplated that liquid spray-on foam as used in the automotive industry for sound insulation may be used herewith. If specified by engineer, the structural shells **202** and **204** are fabricated having wire-mesh **46** and **48** at each surface of the panel, which is not a mandatory component during fabrication, and it is understood that such shells are made from cementitious material **50** as shown in FIG. **1**.

[0018] It is understood that trusses **42** in FIG. **1** can be either of truss combinations shown in FIG. **2**, FIG. **3**, FIG. **4**, FIG. **5**, or FIG. **6**. Specifically, as shown in FIG. **2**, a zig-zag or "warren" truss may be used, or a ladder truss as shown in FIG. **3**, a truss combining both a ladder truss and a warren truss as shown in FIG. **4** (which is more clearly defined in FIG. **5**), or a combination truss as shown in FIG. **6**.

[0019] Next, the trusses **42** are fed into the foam spray chamber **301** of the fabrication machine shown in FIG. **7** over roller conveyer mechanism, also described herein as the elongated flat conveyer mechanism **305**. The chamber **301** has first and second rotating drive mechanisms **302** and **304** which move in a manner that the linear speed of the rotating member's surface is the same as the feeding speed of trusses **42**. Preferably, the first and second drive mechanisms **302** and **304** are formed having a plurality of mechanically driven belt **400** forming a substantially triangular shape. Even more preferably, each of the first and second drive mechanisms **302** and **304** have 3 sets of 2 mechanically driven rollers **400**. A secondary belt **402** may then be wrapped around these sets of rollers and belts. The belt may be formed of a rubber-like material or any other material that is suited for providing traction with the foam formed by the spray nozzles **303**.

[0020] Next, the expandable foam or equivalent expandable material **14** is being continuously spraved into the chamber **301** through nozzles **303**. The number of nozzles spraying into the chamber **301** and spraying speed shall be calibrated in order to fill the space between the rotating surfaces fully. The machine **10** is also highly customizable such that the distance between the first and second drive mechanisms **302** and **304** may be adjusted to provide for a larger or smaller chamber **301**, ultimately resulting in a thicker or thinner panel respectively. The density of the foam may also be adjusted by calibrating the foam spray speed and intensity. It is understood that when implementing polystyrene into the present invention, the system **10** may be modified such that bits of polystyrene may be fed along the conveyer system **305**. Instead of the nozzles **303** being formed to spray liquid foam, the nozzles may instead spray steam into the chamber **301** so as to expand the styrene bits such that they are shaped by the first and second drive mechanisms **302** and **304**.

[0021] Once the panel exits the chamber **301**, first and second cutting blades **404** and **406** are positioned adjacent the first and second drive mechanisms **302** and **304** to trim off excess foam. Thereafter, the finished panel product is being saw-cut into lengths given by the engineer for specific construction project.

[0022] If a wire-mesh is specified by the engineer, it can be attached to the truss chords either by metal wire or by touch welding or by any alternative method securing proper attachment of the wire mesh to the truss apexes (not shown). The attachment of the wire mesh can take place either at the fabrication plant or at the job site, depending on convenience.

[0023] Next, panels are transported to the job site and being installed based on the design drawings provided by Architect and Engineer. It is mandatory, that the panels must be shored properly to remain on place during the application of the cementitious skins **202** and **204**. At locations of connections of two separate panels installed next to each other vertically as walls, horizontally as floors or inclined as roofs, additional wire mesh shall be attached at the location of the joint along joint's full length.

[0024] Finally, the cementitious material is being placed on the both surfaces of the panels and trawled to create uniform shells **202** and **204**.

1. A machine for fabricating a composite structural panel having a plurality of trusses held together by foam, the machine comprising:

an elongated generally flat conveyer system having a plurality of elongated cylindrical rollers positioned horizontally along the conveyer system for receiving trusses vertically positioned along the conveyer system in spaced-apart relation and allowing the trusses to traverse thereacross;

first and second drive mechanisms each having at least one generally flat portion on a side thereof, the first drive mechanism having the at least one generally flat portion positioned coplanar to the conveyer system for engaging and feeding one side of the panel therethrough, the second drive mechanism being positioned in opposed relation to the first drive mechanism for engaging and feeding another side of the panel therethrough, the first and second drive mechanisms collectively defining a foam spray chamber therebetween;

a plurality of spray nozzles positioned across the conveyer system in spaced-apart relation and pointed toward the foam spray chamber for forming foam between each side of the panel; and

first and second cutting blades being positioned adjacent a side portion of the first and second drive mechanisms respectively for trimming excess foam from the panel.

2. The machine as in claim **1** further comprising liquid expandable foam configured to be expelled from the spray nozzles into the chamber.

3. The machine as in claim **1** wherein the first and second drive mechanisms are triangular shaped.

4. The machine as in claim **1** wherein each of the first and second drive mechanisms further includes a plurality of rollers and a secondary belt extending over the rollers.

5. A method of fabricating a composite structural panel, the method comprising the steps of:

a) selecting a composite structural panel for fabrication having at least two structural shells, an expandable insulating material therebetween, and a plurality of truss members embedded therebetween; and

b) forming a structural panel fabrication machine for fabricating the composite structural panel selected in step (a), the machine having:

an elongated generally flat conveyer system having a plurality of elongated cylindrical rollers positioned horizontally along the conveyer system for receiving trusses vertically positioned along the conveyer system in spaced-apart relation and allowing the trusses to traverse thereacross,

first and second drive mechanisms each having at least one generally flat portion on a side thereof, the first drive mechanism having the at least one generally flat portion positioned coplanar to the conveyer system for engaging and feeding one side of the panel therethrough, the second drive mechanism being positioned in opposed relation to the first drive mechanism for engaging and feeding another side of the panel therethrough, the first and second drive mechanisms collectively defining a foam spray chamber therebetween,

a plurality of spray nozzles positioned across the conveyer system in spaced-apart relation and pointed toward the foam spray chamber for forming foam between each side of the panel, and

first and second cutting blades being positioned adjacent a side portion of the first and second drive mechanisms respectively for trimming excess foam from the panel.

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