A METHOD OF TRANSPORTATION AND ASSEMBLY OF BUILDING MODULES

Abstract: A method of construction and site installation of a structure including at least one prefabricated module attachable to a base structure. The method comprises the steps of: a) constructing a ground engaging foundation; b) providing on the foundation at least one strut having a fixed end anchored to the foundation and a free end terminating in a support; c) preparing a substructure to engage the support on each said at least one strut and to receive and retain a sub floor for at least one said prefabricated module; d) factory prefabrication of said at least one module; e) placing each said modules on said supports such that the sub-floor of the module engages the support on each said strut; f) fixing the subfloor of each module to the support on said struts. The modules are designed such that they are capable of nesting within each other for transportation.
A METHOD OF TRANSPORTATION AND ASSEMBLY OF BUILDING
MODULES

BACKGROUND

The present invention relates to improvements in and relating to modular building construction and more particularly to the transportation and assembly of modules which are capable of nesting within each other for transportation and separation for mutual engagement on site to form a dwelling, preferably though not exclusively to single and multi-storey and split level dwellings.

More particularly the invention relates to a method of prefabricated construction using cooperating modules which may be stacked for transportation such that all modules for a building are able to fit within a footprint of one module. The present invention further relates to methods of prefabricated factory production of such modules which allow the above nesting and to their methods of site assembly and particularly installation and assembly on or to existing structures. More particularly the invention provides a method of prefabricated manufacture of transportable modules which nest for transportation and which are assembled on site in a completed or substantially completed form.

Although the invention will be primarily described with reference to its application in structures for domestic habitation it will be appreciated that the invention has other applications in areas such as but not limited to industrial constructions, site offices, additions and the like.

PRIOR ART

Modular prefabricated construction is well known in the housing industry. There are a variety of known transportable modular prefabricated units which have been employed in a variety of filed applications and particularly in remote areas where there is often little or no access to trades personnel. Known in the art are transportable
buildings commonly known as relocatable homes used for such applications as classrooms, site offices temporary accommodation in remote areas and emergency housing such as in disaster zones. These are generally small sized units which can be no larger than the transport vehicle allows.

Other single storey dwellings which are prefabricated in a factory and transported for assembly to a site are a more permanent style of transportable dwellings. Generally prefabricated housing modules or part modules must be limited to dimensions of height, width and length which a transport vehicle will accommodate. Capacity for transportation is usually the limiting factor which governs the size, weight and extent of finish of a prefabricated module. This limitation puts restrictions on the size of each module and therefore the size of dwellings constructed from such modules.

Standards of living in western countries have risen by a large degree in the last two decades. The effect of this has been to create a more discerning market attitude on behalf of the home or dwelling purchaser. Prefabricated concrete housing was one form of housing adopted in the 1970's intended for poorer countries but this did not meet with the success that it might have had, due to unfavourable economic conditions and the difficult of using concrete and the associated raw materials in remote areas.

Concepts of room sized modules such as described in Australian Pat. No. 464,495, coped more effectively with changing architectural styles and tastes but only represented a very low percentage of the cost of the finished dwelling. Capital investment in factory and plant to produce these modules became too high to complete openly to any large degree with conventional construction. For modular construction to be feasible, it must compete economically with conventional constructions. The room sized module concept was practical in that the type of module, its costs, flexibility of planning was still superior to large precast panel construction. In another example of the prior art, United States Patent 4,432,171 discloses a room sized building module made up of a three dimensional skeletal frame comprising wall frames and a ceiling frame constructed as a unitary integral structure adapted to be attached or moulded to a
floor. The whole frame is constructed in a reinforced concrete matrix material and is formed around and bonded to a pre made sheet of lining material strong enough to be self supporting between the frame members. The lining material and the frame combine together structurally to provide a rigid transportable module. Since each module is room sized, it is clear that to construct a dwelling out of the modules, numerous transportation vehicles would be employed so the dwelling could be transported room by room. This adds high transportation costs and in some cases can negate the economic benefits of modular prefabricated construction in comparison to full site construction from the ground up. A major segment of the market is the single family dwelling. Such dwellings are erected on separate plots or lots of land of differing dimensions. Factory built housing must accommodate changes in dimensions of available foundations to be viable.

Methods of prefabricating room sized building modules having walls and a ceiling is known. Conventional constructions are adapted to the major sections of the market as mass production lines cannot adjust readily or economically to too many variations or alterations.

Traditionally, light weight stud frame construction may employ studs of timber or metal (steel or aluminium) stud members. A standard form metal stud frame will usually comprise a series of spaced apart stud members which each engage via their ends respective opposing top and bottom plate members. Steel members are generally channel shaped and the ends of the stud members engage channel shaped plate members. According to conventional methodology, the frames are generally assembled on the ground. Typical frame construction involves placement of top and bottom plate members in spaced apart opposing relationship whereupon stud members are connected to the top and bottom plates which traditionally involves engaging the ends of the studs with tech screws or the like. These frames may or may not be braced but in the case where they are not braced with bracing members, reliance for bracing is placed on tech screws. The above frames may be either be constructed on site or prefabricated and delivered in pieces to site for assembly.
The profiles of the known metal studs and plates are channel shaped with a planar base and sidewalls extending from and continuous with the edges of the base.

Although the above prefabricated modular design concepts have served useful purposes, the problem in the past has been that in remote areas, transportation costs and the physical size of transport vehicles limit the size of the dwellings that can be constructed from prefabricated modules to essentially the sizes of the transport vehicle's carrying capacity. If dwellings greater than the size of an available transport vehicle, then multiple vehicles or multiple trips to site are required contributing significantly to the costs and this can minimize or negate the economic value of module prefabricated constructions.

**INVENTION**

There is a long felt want in the industry to provide an improved, efficient and economic method of modular construction which solves the problem of high cost transportation and allows for transportation of one dwelling which can be many times larger than the transportation vehicle used in the transportation of the modules.

The present invention provides in one form modular building elements capable of nesting within each other for transportation and separation for mutual engagement on site to form a dwelling, preferably though not exclusively to single storey dwellings. The invention also provides a method of prefabricated construction using co operating modules which may be stacked for transportation such that all modules fit within a foot print of one module. The present invention further provides a method of prefabricated manufacture of transportable modules which nest for transportation and which are assembled on site in a completed or substantially completed form to form a modular structure of much larger dimensions than have been available in modular construction in the past.

The invention further provides methods of prefabricated factory production of such co operating modules and methods of site assembly of such modules or part modules.

The invention also provides a method of prefabricated manufacture of transportable
modules which are assembled on site in a completed or substantially completed form
and which are lifted from a transport vehicle to site.

Although the invention will be primarily described with reference to its application in
structures for domestic habitation it will be appreciated that the invention in its various
forms has applications in other than domestic dwellings.

One object of the invention is to improve techniques for transportation of modular
housing. The present invention further provides an alternative to the known
prefabricated production and transportation methods and more particularly a method
which is quick, convenient to execute, reduces transportation and labour costs, reduces
construction time due to a reduction in transportation time and which lends itself to
mass production.

In factory prefabricated manufacturing a large size space is required when fully
completed modules are to be created for later transportation. By constructing part
modules which are fully completed, save for site engagement with an associated
module, this reduces the footprint of each module and the footprint for the whole
dwelling to be constructed from the modules. Also since the part modules can nest
against and/or within each other, two or more modules which make a completed
dwelling when assembled on site can be transported in one load. According to the prior
art modules each one had to be transported on a separate vehicle (usually oversized).
According to the prior art, being three dimensional and room sized creates a demand
for much larger transport vehicles and factory space. The space taken up by modules
and their transportation is an issue which determines the economics of modular
construction. Transportation of modules has been a major contributor to costs and can
offset the savings achieved by prefabricated constructions. It is desirable if
transportation costs can be reduced to avoid this offset in savings. The present
invention provides a relatively light weight module or part thereof for ease of transport
and erection and which co operates with at least one other module so that the modules
can fit together for transportation so that multiple modules can fit on one vehicle or at
least take up a footprint which is not much greater than a footprint of a single module. The interior finishing of each module is factory completed and only minimal site works to internal finishings if any are required to complete assembly.

A major advantage of the modular building system according to the invention is economy of transportation for a larger size modular structure. Each module must be strong enough to be lifted, transported and erected via a lifting device such as a crane without distress or damage.

It is one object of the invention to produce a module with a minimal amount of on site labour and which is easily transportable with other modules on a transport vehicle. It is a further object of the invention to provide modules which interfit or nest adjacent or within each other to enable a plurality of modules to fit on a vehicle within the footprint of just one said modules. It is a further object of the invention to provide a modular dwelling fabricated from a plurality of co operating modules and which are stackable for transportation. It is a further objection of the invention to reduce the costs of modular construction by reducing transportation costs and to reduce the time between factory fabrication, transportation and erection at site. It is a further object of the invention to produce modules of the type mentioned above and which have relatively low weight.

The invention according to one embodiment, consists in a prefabricated module which according to one embodiment includes a skeletal frame comprising wall frames and a ceiling or truss frames and constructed as a unitary integral structure adapted to be attached to a foundation. The frames are clad with lining material strong enough to resist transportation induced loads and normal live and dead loads incident during the life of the structure. The frame members, the cladding material combine together structurally to provide a rigid transportable module.

In a broad form of a method aspect the present invention comprises:

a method of construction and site installation of a structure including at least one pre fabricated module attachable to a base structure the method comprising the steps of:
a) constructing a ground engaging foundation;
b) providing on the foundation at least one strut each having a fixed end anchored to the foundation and a free end terminating in a support means;
c) preparing a substructure to engage the support on each said at least one strut and to receive and retain a sub floor of at least one said prefabricated modules;
d) factory pre fabrication of said at least one module;
e) placing each said modules on said substructure such that the subfloor of the module engages the substructure which in turn engages the support means on each said strut;
f) fixing the subfloor of each module to the substructure and fixing the substructure to the support means on said struts.

In another broad form of the method aspect the present invention comprises:
a method of site installation of a prefabricated building using transportable co operating modules attachable to a support foundation on a building site, the method comprising the steps of:
a) prefabricating at least two building modules capable of forming at least part of a structure;
fabricating a first said modules defining an internal space which allows at least a second module to fit within a footprint defined by the first module for transportation;
preparing a site foundation including a support structure to receive and retain the prefabricated modules;
transporting said modules to a building site;
removing said at least a second module from the first module and seating each said modules onto the support structure so it is retained by the base structure;
fixing one module to another module and fixing each said modules to the support structure;
finishing the co operating modules internally and externally.

In a broad form of an apparatus aspect, the present invention comprises:
a pre fabricated transportable building formed from a plurality of co operating modules
adapted for attachment to a ground engaging foundation; characterized in that each
module forms at least part of a finished structure and is capable of nesting with at least
one other modules for transportation on a transport vehicle so that during
transportation, a building to be formed from the co operating modules is substantially
retained within a footprint defined by one module.

The module includes means thereon to allow attachment of the module to a support
structure located at a site; wherein the module co operates with at least one other
module to form a completed dwelling.

In another broad form the present invention comprises:
a light weight transportable module or part thereof constructed as a unitary integral
structure adapted to be attached to a floor;
wherein, the module co operates with a corresponding module wherein the modules
are so constructed as to allow them to nest in co operation with at least one other
module.

In another broad form the present invention comprises:
a pre fabricated building formed from a plurality of co operating modules adapted for
attachment to a base structure; characterized in that each module forms at least part of a
finished structure and is capable of nesting with at least one other modules for
transportation on a transport vehicle so that during transportation, a building to be
formed from the co operating modules is substantially retained within a footprint
defined by one module.

The at least one module has a rigid steel base which is fixed to the support structure. A
module may be constructed from at least two co operating modules. Preferably, a
module size is determined by a maximum size which is transportable.

Each module or part thereof is preferably crane lifted into position but it will be appreciated by persons skilled in the art that other forms of lifting are available such as by crane.

The present invention provides an alternative to the known prior art and the shortcomings identified. The foregoing and other objects and advantages will appear from the description to follow. In the description reference is made to the accompanying representations, which forms a part hereof, and in which is shown by way of illustration specific embodiments in which the invention may be practiced. These embodiments will be described in sufficient detail to enable those skilled in the art to practice the invention, and it is to be understood that other embodiments may be utilized and that structural changes may be made without departing from the scope of the invention. In the accompanying illustrations, like reference characters designate the same or similar parts throughout the several views. The following detailed description is, therefore, not to be taken in a limiting sense, and the scope of the present invention is best defined by the appended claims.

DETAILED DESCRIPTION

The present invention will now be described in more detail according to preferred but non limiting embodiments and with reference to the accompanying illustrations wherein;

Figure 1 shows a plan view of an assembly of co operating outer and extended modules and inner walls nested for transportation prior to assembly.

Figure 2 shows a plan view of the assembly of figure 1 with the extended module exploded

Figure 3 shows a plan view of the assembly of figure 1 with the extended module set adjacent the outer module to define an internal space of a dwelling.

Figure 4 shows a perspective view of typical corner connection details according to one embodiment.

Figure 5 shows a side elevation portion of joist frame detail showing skirting covering.
Figure 6 shows a side elevation portion of ceiling frame connection detail.

Figure 7 shows a side elevation of the module assembly 1 of figure 1 ready for transportation.

Figure 8 shows an end elevation of assembled modules.

Figure 9 shows a plan view of the dwelling when the modules are assembled.

Figure 10 shows a front elevation view of the dwelling when assembled.

Figure 11 shows a side elevation of a module assembly according to an alternative embodiment nested ready for transportation.

Figure 12 shows an end elevation of assembled modules.

Figure 13 shows an opposite end elevation of assembled modules.

Figure 14 shows a rear elevation view of the dwelling of figure 13 when the modules are assembled.

Figure 15 shows a front elevation view of the dwelling of figure 13 when assembled.

Figure 16 shows a plan view of the dwelling of figure 13 when assembled.

Figure 17 shows according to one embodiment a plan view of a foundation layout for a typical module assembly installation.

Figure 18 shows a side elevation of the foundation layout of figure 17.

Figure 19 shows an enlargement of bearer and subfloor joist joined by a connection plate.

Figure 20 shows a front elevation of the foundation layout of figure 17 and 18.

Referring to figure 1 there is shown a plan view of an assembly of modules which are integrated in a state which is ready for transportation. An outer module includes walls which define a space which is capable of receiving and retaining nesting modules so that during transportation a plurality of modules can be transported within a footprint of an outer module.

Assembly 1 shows nesting modules 2 and 3 configured for transportation as it would appear on the tray of a transport vehicle. Assembly 1 comprises operating outer module 2 and extension module 3. Inner walls 4 and 5 are shown nested for transportation adjacent wall section 6 of module 3. Outer module 2 includes an outer wall 7 and side
wall members 8 and 9. As can be seen from figure 1 outer module 2 includes prefabricated internal rooms 10, 11, 12, 13 and 14 where room 10 is a bedroom, room 11 a toilet, room 12 an open area, room 13 a kitchen area and room 14 a laundry. It will be appreciated that the floor plan layouts shown in outer module 21 and extension module 3 of figure 1 is one of many non limiting possible layouts for each cooperating module. Extension module 3 includes long wall 6 and side walls 17 and 18. Long wall 6 is dimensioned to enable side walls 17 and 18 to contain side walls 8 and 9 of module 2 to thereby allow module 3 to 'nest' against module 2. Module 2 according to the embodiment shown nests with a footprint of module 3. Side wall 17 locates outside wall 8 of module 2 and side wall 18 of module 3 locates outside wall 9. This relationship between the walls allows modules 2 and 3 to interleave. When on site module 3 is separated from module 2 so that a building manufactured from the modules can be at least twice the size of the module having the smaller footprint. Modules 2 and 3 are supported via sub structure joist frame 19 which includes joists 20. Figure 1 shows the modules from a plan view as they would be stacked for transportation on a transport vehicle. It will be appreciated that the configurations of modules 2 and 3 shown in figure 1 are examples of a potentially unlimited number of module configurations in which at least one other module or part of a module, can nest in a primary module. There are a potentially unlimited number of internal floor plan layouts which can be finished from a basic module having walls and a base. Each module is adapted with lifting lugs which allow the modules to be lifted for transportation. Lugs are distributed to ensure that the module weight is taken at or near its centre of gravity to ensure balance of the module during lifting. Typically lifting lugs will be placed at a location one third the distance from each end of the modules at approximate locations A, B, C and D.

Figure 2 shows with corresponding numbering a plan view of a partially assembled module assembly of figure 1 with the extended module 3 separated from outer module 2. Module 2 is shown located on a foundation (obscured) surrounded by peripheral deck area 60. The deck can be constructed on site or transported in pieces for assembly at the site. Wall members 4 and 5 are shown located into position which will define rooms
when module 3 is engaged to module 2. Module 3 is shown remote from module 2 but it can be seen from the separation that a relatively large size building emerges from nested modules having a footprint originally defined by one module. Thus a building formed from for example, from three or more modules can be transported within the footprint of a largest module and when on site the modules can be expanded from a transport configuration and set in a final location to form the building. One advantage of this is a reduction in transport costs for buildings which are relatively large when completed. This allows the transportation of the majority if not all of one building in one trip. Module 3 as shown further comprises pillars 35 and 36 which transfer loading from roof truss 37 to footings via substructures.

**Figure 3** shows with corresponding numbering a plan view of the assembly of figure 1 with the extended module 3 set adjacent the outer module 2 to define an internal space of a dwelling.

**Figure 4** shows a perspective view of connection details of a module in isolation from foundations according to one embodiment. A ground engaging foundation is not shown in this view but includes struts which each terminate in a support plate to receive and retain substructure 19 (see figures 17a, b and c). Substructure 19 includes a frame 38 which provides a base on which module sub floor frame 21 of module assembly 50 is supported. Sub floor frame 21 is connected to substructure 19 via opposing flanges 22 and 23. Fasteners 24 and 24a are used to complete the connection between flanges 22 and 23. Mounted on sub floor frame 21 is a wall bottom plate 25 which is preferably channel shaped and receives and retains studs 26 and 27. Studs 26 and 27 (abbreviated) which are retained by top plate 28, support ceiling frame 29. Bottom plate 25 is fastened to Flange 52 via fasteners which are according to one embodiment, heavy duty bolts. Alternative fastenings may be used such as welding or clamping. Welding can also be used for permanent connections. Flooring cladding 30 is laid over subfloor frame 21 and comprises an internal floor surface for the module 50. Openings 55 and 56 are provided for services such as plumbing, electrics and water. The aforesaid arrangement is replicated throughout a typical module footprint. It will be appreciated that alternative structural sections to those shown can be used such as but not limited to angle sections,
beams, C sections, channels or tubes.

**Figure 5** shows a side elevation portion of substructure 19 detail showing skirting covering 20. Outside cladding 31, covers stud 26 and floor frame 21. Floor boards 30 may be laid on top of sub floor frame 21. Ceiling cladding is fixed to ceiling frame 29 receives and retains ceiling board 34.

**Figure 6** shows with corresponding numbering a side elevation portion of ceiling frame connection detail. Ceiling frame 29 is connected to strip bracket 32 which is welded to top plate 28. Skirting 33 is placed to provide an external finish.

**Figure 7** shows a side elevation of the module assembly 1 of figure 1 ready for transportation with modules 2 and 3 engaged in nesting relationship. **Figure 8** shows with corresponding numbering, an end elevation of assembled modules 2 and 3 of figure 1 viewed from the end nearest room 14 of figure 1. In this embodiment, the assembly 1 includes a folded verandah roof 40 and posts 41 (see figure 10). **Figure 9** shows a plan view of the dwelling when the modules 2 and 3 are fully assembled. **Figure 10** shows a front elevation view of the dwelling when assembled including fully assembled posts 41 and roof 40. It can be seen by comparing side elevation figures 7 and 8 that the assembled structure shown in figure 8 can be reduced for transportation as shown in figure 7. According to prior art methods, each module required transportation on separate vehicles. The present invention allows the transportation of whole structures by inter fitting of modules. The inter fitting may be effected by either lowering one module into another and fitting an ancillary parts or walls or by side coupling.

**Figure 11** shows a side elevation of a module assembly 60 according to an alternative embodiment with modules 61 and 62 nested ready for transportation. **Figure 12** shows an end elevation of assembled modules 61 and 62 of figure 12 and an optional additional structure 63. It can be seen from a comparison of figures 11 and 12 that the footprint defined by the modules for transportation can be at least a third less than the footprint taken by the completed structure. Module 61 is received inside module 62 as
shown in figure 11. Figure 13 shows with corresponding numbering, an opposite end
elevation of assembled modules of figure 12. Figure 14 shows a front elevation view of
the dwelling of figure 13 when assembled. Figure 15 shows a rear elevation view of the
dwelling of figure 13 when assembled. Figure 16 shows a plan view of the dwelling of
figure 13 when the modules are assembled.

Figure 17 shows according to one embodiment a plan view of a foundation layout 70
for a typical module assembly installation. Layout 70 comprises twelve like footings 71
spaced apart to accommodate rear bearer 72, centre bearer 73 and front bearer 74.

Figure 18 shows a side elevation of the foundation layout 70 of figure 17. Layout 70
comprises footings 75, 76 and 77 which respectively retain posts or struts 78, 79 and 80.
Mounted on struts 78, 79 and 80 are support plates which receive and retain bearers 84,
85 and 86 of substructure 87.Mounted on bearers 84, 85 and 86 is a subfloor 88
comprising joists 100 mounted via plate 103 and sub floor webbing 101 which is
integral with a module (not shown for clarity). Subfloor 88 is finished with floor
cladding 89 which is located inside modules mounted on subfloor 88. Figure 19 shows
an enlargement of bearer 85 and subfloor joist 100 joined by plate 103. Cantilever frame
91 supports a peripheral deck frame 92 including parallel channels 93. Figure 20 shows
a front elevation of the foundation layout 70 of figure 17 and 18. From this view it can
be seen that layout 70 comprises footings 93, 94, 95 and 77 shown just below ground
level 104. Extending from footings 93, 94, 95 and 77 are struts 105, 106, 107 and 80.

Subfloor 88 which is integral with a module (not shown) is finished with floor
cladding 89 which locates inside modules mounted on subfloor 88.

It will be appreciated that the arrangements described above can be varied according to
site requirements. The invention provides sequenced, intra stacked transportable
modules with the stackability allowing space economy for transportation and storage
prior to assembly on site.

It will be recognised by persons skilled in the art that numerous variations and
modifications may be made to the invention broadly described herein without departing
from the overall spirit and scope of the invention.
THE CLAIMS DEFINING THE INVENTION ARE AS FOLLOWS:

1. A method of construction and site installation of a structure including at least one prefabricated module attachable to a base structure the method comprising the steps of:
   a) constructing a ground engaging foundation;
   b) providing on the foundation at least one strut each having a fixed end anchored to the foundation and a free end terminating in a support means;
   c) preparing a substructure to engage the support on each said at least one strut and to receive and retain a subfloor of at least one said prefabricated modules;
   d) factory pre fabrication of said at least one module;
   e) placing each said modules on said substructure such that the subfloor of the module engages the substructure which in turn engages the support means on each said strut;
   f) fixing the subfloor of each module to the substructure and fixing the substructure to the support means on said struts.

2. A method according to claim 1 comprising the further step of preparing modules for the structure comprising a first module defining walls, a base, a base footprint and at least one other module including walls and a base and which is sized to enable insertion of each said at least one other modules inside the footprint of the first module.

3. A method according to claim 2 comprising the further step of prior to assembly of said modules on site, transporting said first and said at least one other module within the footprint of the first module.

4. A method according to claim 3 comprising the further step of nesting operating modules for transportation on a transport vehicle;
5. A method according to claim 4 comprising the further step of placing the first module on said support and separating said at least one other module from said first module.

6. A method according to claim 5 comprising the further step of engaging modules side by side and securing the modules to said foundation support means via the subfloor of each module.

7. A method according to claim 6 comprising the further step of permanently fixing one module to an adjacent operating module.

8. A method according to claim 7 comprising the further step of finishing the operating modules internally and externally.

9. A method according to claim 8 wherein the engaging foundation comprises a concrete footing;

10. A method according to claim 9 wherein the foundations include composite piers having a concrete base receiving and retaining said struts

11. A method according to claim 10 wherein the struts terminate in support plates which each receive a part of the substructure.

12. A method according to claim 11 wherein the support plates are welded to the struts and include openings to receive fasteners to retain the substructure.

13. A method according to claim 12 wherein the struts comprise steel sections are selected from an angle, I beam, channel, C section, tubular section.

14. A method according to claim 13 wherein the substructure comprises, a
peripheral frame manufactured from sections selected from one or more angle section, I beam, channel, C section, tubular section.

15. A method according to claim 14 wherein the substructure includes joists which support the subfloor of each module.

16. A method according to claim 15 wherein the subfloor of each module includes a peripheral frame which retains supporting joists extending between the frame.

17. A method according to claim 16 wherein the subfloor of each module is manufactured from profiles selected from one or more angle section, I beam, channel, C section, tubular section.

18. A method according to claim 17 wherein each module includes a wall mounted on said subfloor defining an internal living space.

19. A method according to claim 18 wherein each module includes lifting lugs located to enable balance of the modules upon lifting for transportation and setting in position.

20. A method according to claim 19 wherein the weight of each module is distributed to the lifting lugs when the module is lifted.

21. A method according to claim 20 wherein there are four lifting points on each module.

22. A method according to claim 21 wherein at least two modules are capable of retention within in the footprint defined by the first module for the purposes of transportation.
A method of site installation of a pre fabricated building using transportable operating modules attachable to a support foundation on a building site, the method comprising the steps of:

a) prefabricating at least two building modules capable of forming at least part of a structure;

fabricating a first said modules defining an internal space which allows at least a second module to fit within a footprint defined by the first module for transportation;

preparing a site foundation including a support structure to receive and retain the prefabricated modules;

transporting said modules to a building site;

removing said at least a second module from the first module and seating each said modules onto the support structure so it is retained by the base structure;

fixing one module to another module and fixing each said modules to the support structure;

finishing the co operating modules internally and externally.

A method according to claim 23 wherein said at least one other module is/are sized to nest insider the first module such that all modules are transportable together within the footprint of the first module.

A pre fabricated transportable building formed from a plurality of co operating modules adapted for attachment to a ground engaging foundation; characterized in that each module forms at least part of a finished structure and is capable of nesting with at least one other modules for transportation on a transport vehicle so that during transportation, a building to be formed from the co operating modules is substantially retained within a footprint defined by one module.

A pre fabricated transportable building according to claim 25 wherein
the ground engaging foundation comprises a concrete footing which receives and
retains a plurality of struts each having a fixed end anchored to the foundation and a
free end terminating in a support.

27. A pre fabricated transportable building according to claim 26 further
comprising a substructure which engages said supports.

28. A pre fabricated transportable building according to claim 27 wherein the
substructure receives and supports a subfloor of said modules.

29. A pre fabricated transportable building 28 according to claim wherein the
subfloor comprises a rigid steel base which receives a module and is fixed to the sub
structure.

30. A transportable building according to claim 29 wherein the foundations
include composite piers having a concrete base receiving and retaining said struts

31. A transportable building according to claim 30 wherein the struts terminate
in support plates which each receive a part of the substructure.

32. A transportable building according to claim 31 wherein the support plates
are welded to the struts and include openings to receive fasteners to retain the
substructure.

33. A transportable building according to claim 32 wherein the struts comprise
steel sections are selected from an angle, I beam, channel, C section, tubular section.

34. A transportable building according to claim 33 wherein the substructure
comprises, a peripheral frame manufactured from sections selected from one or more
angle section, I beam, channel, C section, tubular section.
35. A transportable building according to claim 34 wherein the substructure includes joists which support the sub floor of each module.

36. A transportable building according to claim 35 wherein the subfloor of each module includes a peripheral frame which retains supporting joists extending between the frame.

37. A transportable building according to claim 36 wherein the subfloor of each module is manufactured from profiles selected from one or more angle section, I beam, channel, C section, tubular section.

38. A transportable building according to claim 37 wherein each module includes a wall mounted on said subfloor defining an internal living space.

39. A transportable building according to claim 38 wherein each module includes lifting lugs located to enable balance of the modules upon lifting for transportation and setting in position.

40. A transportable building according to claim 39 wherein the weight of each module is distributed to the lifting lugs when the module is lifted.

41. A transportable building according to claim 40 wherein there are four lifting points on each module.

42. A transportable building according to claim 41 wherein at least two modules are capable of retention within in the footprint defined by the first module for the purposes of transportation.

43. A pre fabricated transportable building 42 according to claim wherein the building may be constructed from at least two co operating modules.
44. A pre fabricated transportable building according to claim 43 wherein the module size is determined by a maximum size which is transportable.

45. A pre fabricated transportable building according to claim 44 further comprising a first module which defines a footprint and at least one other module which nests inside the first module for transportation purposes.

46. A portable prefabricated module for use in construction of a dwelling and which forms at least part of said dwelling, wherein the module comprises; at least a prefabricated part wall, roof and floor proportioned to be of a size which may be accommodated by a transport vehicle for transport of said module to a building site, means on the module to allow attachment of the module to a support structure located at a site; wherein the module co operates with at least one other module to form a completed dwelling.

47. A light weight transportable module or part thereof constructed as a unitary integral structure adapted to be attached to a foundation; wherein a first module is so constructed as to allow retention of at least one other co operating module in an internal space for transportation purposes, wherein the at least one other module received in the first module is releasable for constructions and assembly purposes.
**INTERNATIONAL SEARCH REPORT**

**International application No.**
PCT/AU20 11/000866

### A. CLASSIFICATION OF SUBJECT MATTER

Int. Cl.

*E04B 1/343 (2006.01) E04B 1/348 (2006.01) E04H 1/02 (2006.01)*

According to International Patent Classification (IPC) or to both national classification and IPC

### B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

WPI, EPODOC :/EC/IC OR E04B1/343, E04B1/348, E04H1 and keywords: modul+, prefab+, foundation, joist+, nest+ and similar terms

### C. DOCUMENTS CONSIDERED TO BE RELEVANT

<table>
<thead>
<tr>
<th>Category*</th>
<th>Citation of document, with indication, where appropriate, of the relevant passages</th>
<th>Relevant to claim No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>X</td>
<td>US 2010/00243 14 A1 (POPE) 4 February 2010 Abstract, Figures 1A, 7C</td>
<td>46</td>
</tr>
</tbody>
</table>

* Further documents are listed in the continuation of Box C

- **A** special categories of cited documents:
  - "T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
  - "X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
  - "Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
  - "K" document member of the same patent family

Date of the actual completion of the international search

26 September 2011

Date of mailing of the international search report

26/09/2011

Name and mailing address of the ISA/AU

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Form PCT/ISA/210 (second sheet) (July 2009)
**INTERNATIONAL SEARCH REPORT**

**Box No. II** Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☑ Claims Nos.:
   because they relate to subject matter not required to be searched by this Authority, namely:

2. ☐ Claims Nos.:
   because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. ☑ Claims Nos.:
   because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a)

**Box No. III** Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

See Extra Sheet

1. ☑ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.
2. ☐ As all searchable claims could be searched without effort justifying additional fees, this Authority did not invite payment of additional fees.
3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

4. ☑ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.: 1-22, 46

**Remark on Protest**

- ☑ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.
- ☑ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.
- ☑ No protest accompanied the payment of additional search fees.
A method of construction and site installation of a structure including at least one prefabricated module attachable to a base structure. The method comprises the steps of:

a) constructing a ground engaging foundation;
b) providing on the foundation at least one strut having a fixed end anchored to the foundation and a free end terminating in a support;
c) preparing a substructure to engage the support on each said at least one strut and to receive and retain a sub floor for at least one said prefabricated modules;
d) factory prefabrication of said at least one module;
e) placing each said modules on said supports such that the subfloor of the module engages the support on each said strut;
f) fixing the subfloor of each module to the support on said struts.

The modules are designed such that they are capable of nesting within each other for transportation.
Continuation of Box No: III

This International Application does not comply with the requirements of unity of invention because it does not relate to one invention or to a group of inventions so linked as to form a single general inventive concept.

This Authority has found that there are different inventions based on the following features that separate the claims into distinct groups:

- Claims 1-22 are directed to a method of construction and installation of prefabricated modules. The feature of providing a foundation, strut and substructure on to which the sub floor of the module is placed is specific to this group of claims.

- Claims 23-45 and 47 are directed to prefabricated building modules and a method of installation. The feature of a module being able to fit within another module for transportation is specific to this group of claims.

- Claim 46 is directed to a prefabricated building module. The feature of the modules being sized for vehicle transport, attachable to a support structure on site and cooperates with another module to form a dwelling is specific to this group of claims.

PCT Rule 13.2, first sentence, states that unity of invention is only fulfilled when there is a technical relationship among the claimed inventions involving one or more of the same or corresponding special technical features. PCT Rule 13.2, second sentence, defines a special technical feature as a feature which makes a contribution over the prior art.

When there is no special technical feature common to all claimed inventions there is no unity of invention.

In the above groups of claims, the identified features may have the potential to make a contribution over the prior art but are not common to all the claims and therefore cannot provide the required technical relationship. The only feature common to all of the claims and which provides a technical relationship among them is prefabricated, transportable building modules. However this feature does not make a contribution over the prior art because it is disclosed in the prior art listed at page 2 line 29 of the description:

US 4432171 A (BOOT) 21 February 1984

Therefore in the light of this document this common feature cannot be a special technical feature. Therefore there is no special technical feature common to all claimed inventions and the requirements for unity of invention are consequently not satisfied *aposteriori.*
This Annex lists the known "A" publication level patent family members relating to the patent documents cited in the above-mentioned international search report. The Australian Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

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<td>WO 9928572 AU 17067/99</td>
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Due to data integration issues this family listing may not include 10 digit Australian applications filed since May 2001.

END OF ANNEX