

CONNECTION SYSTEM

FIELD

The present description relates to connection systems for interconnecting individual building modules.

In one form the present description relates to connectors for interconnecting two or more individual building modules together which modules can be similar or identical modules or can be different modules from one another.

In one form the present description relates to building structures formed from multiple individual building modules being interconnected together by one or more forms of connectors to form an array or assembly of modules, particularly an array or assembly for forming the building structure.

In one form the present description relates to methods of interconnecting two individual building modules using one or other form or forms of the connectors.

In one form the present description relates to methods of constructing building structures from multiple individual building modules using one or other forms of the connectors for the to interconnect the individual building modules.

In one form the present description relates to lightweight building modules having lightweight infill panels forming one or more of the sides and/or ends and/or roof or floor of the module.

In one form the present description relates to lightweight building modules which are substantially finished in a manufacturing facility or similar prior to lifting into position on-site to form the building structure, including modules having substantially complete built-in componentry, including fittings, fixtures, ancillaries, services, facilities and components.

In one form the present description relates to lightweight, prefinished, prefabricated building modules containing all necessary equipment, fittings and fixtures, including a variety of different modules, such as for example, bathroom modules, kitchen modules, laundry modules or similar, so that all that is required to complete installation of the module after being located in the required position and connected to contiguous modules within the building structure is the connection of mechanical, electrical and plumbing services or facilities (MEP) and the completion of cosmetic/decoration/ascetic treatments.

In one form the present description relates to individual building modules for use in lightweight prefabricated pre-finished volumetric constructions, and to methods of forming building structures from such lightweight prefabricated prefinished volumetric constructions.

Although the present description is directed to specific embodiments of components of a building structure including individual building modules, connectors, building structures, and methods of using such components to construct building structures from the individual modules, it is to be noted that the scope of protection is not restricted to the described embodiments only, but rather the scope of protection is more extensive so as to include other forms, variations and modifications of the building module, the connector, and the building structures, and to methods of forming the building module and building structure other than specifically described.

BACKGROUND

There is an increasing demand for affordable housing, particularly affordable housing of the multi storied or multi-level type, such as for example, high rise apartment blocks, towers, or similar having multiple dwelling spaces or residential units, flats, apartments or the like located at various levels throughout the height of the building structure of the apartment block. Affordable units are provided using different building techniques to reduce the amount of materials used in constructing individual dwelling units and/or to reduce the amount of labour involved in constructing the building structures or both. One suggestion to reduce overall costs of the building structure is to produce individual components of the building structure remotely from the location of the building site, such as for example, in manufacturing facilities, including factories, located off-site to the building site. Another

suggestion is to prefabricate cells, shells or components used in the construction of the building structure remotely from the building site for transportation to the building site by suitable vehicles where the components are assembled together to form the building structure. However, problems are encountered in manufacturing and/or transporting individual components or cells to the building site from the manufacturing facility, including problems associated with interconnecting the various components used to form the building structure.

If the individual components or cells are made sufficiently robust to allow transportation and installation in the building structure without damage to the component or cell or for the building structure to be able to withstand loadings from adverse weather conditions, the component or cell must have sufficient strength and rigidity to withstand flexing, movement, vibration, stress loadings, accidental impact or the like so that heavy weight or heavy duty materials, structures and construction must be used to form the component or cell. The use of such heavy weight or heavy duty materials adds considerably to the overall weight of the component or cell so that lifting of the component or cell into position into the building structure requires the use of heavy duty lifting equipment, such as heavy duty cranes, hoists or similar that are capable of lifting relatively heavy weights. The lifting capacity of the crane or other lifting device limits the weight of the component or cell which can be hoisted into position to form the building structure, as well as limiting the height to which the component or cell can be hoisted, thereby limiting the height of the building structure.

Making the component or cell from lightweight material enabling the structure to be lifted more readily by conventional lifting devices, such as for example, by readily available hoists or cranes, allows unwanted movement of the component or cell during transportation and installation resulting in possible damage thereto because the lightweight material lacks the strength and rigidity to withstand the forces imposed on the component or cell during lifting both onto and off the transport vehicle and hoisting into position during installation. Additionally, after having been lifted into place within the building structure, the component or cell is insufficiently robust to withstand the high stress forces applied to high rise buildings resulting in unacceptable movement of the building and/or damage to the building in adverse weather conditions, including high winds.

In the past, it was difficult to produce lightweight components or cells having sufficient inherent strength and rigidity so as to be durable and resistant to damage but be of sufficiently low weight to be readily lifted into position in the building structure, particularly using more readily available lifting apparatus.

Accordingly, there is a need for individual components or cells of building structures to be both lightweight and strong. Until now such components or cells were not available commercially.

Surprisingly, it has been discovered that the use of lightweight materials for forming individual modules of the building structure can satisfy the apparently conflicting demands of being both lightweight and robust by having sufficient strength and rigidity to withstand stress, strain, impact or similar. Hitherto before, it has been thought that it was difficult to satisfy both of these apparently conflicting demands.

One problem or shortcoming of using individual building modules relates to the interconnection of the modules not only to other adjacent modules but also to other parts of the building, such as for example, structural parts of the building made from reinforced concrete. It is desirable that a building module when connected to another adjacent building module or to a solid support substrate or structure of the building be inhibited from movement, including both lateral movement horizontally from side to side away from and relative to adjacent modules and vertical movement between upper and lower building modules when located in stacked relationship to one another, including being located in off-set relationship or superposed stacked relationship to one another. Accordingly, there is a need for a connection system which inhibits relative movement of a building module with

respect to adjacent building modules, including side-by-side building modules or building modules at different vertical levels such as in stacked relationship to one another.

SUMMARY

- 5 According to one form of the present invention there is provided a connection system for connecting a first module and a structure, comprising
 a first part and a second part,
 the first part and the second part being separate from one another,
 the first part being adapted for fixed attachment to the first module at a first
 10 location,
 the second part being adapted for fixed attachment to the structure at a second location,
 the second part having an anchoring portion for use in securely attaching the second part to the structure in the second location and a guiding portion extending from the
 15 anchoring portion,
 the guiding portion for guiding movement of a fastener for joining the first module and the structure to one another,
 the first location and the second location being arranged such that when the first module and the structure are located in preselected relative position with respect to
 20 each other the first part of the connection system and the second part of the connection system align with each other enabling the fastener to be guided by the guiding portion into cooperative engagement with the first part to interconnect the first module and the structure to one another to maintain the preselected relative position of the first module and structure with respect to one another.
- 25 According to one form of the present invention there is provided a connection system for interconnecting a first module and a structure, comprising
 a first part, a second part, and a third part,
 the first part and the second part being separate to one another,
 the first part being adapted for fixed attachment to the first module at a first
 30 location,
 the first part having a fixed engaging element oriented in a first direction,
 the second part being adapted for fixed attachment to the structure at a second location to extend outwardly therefrom,
 the third part provided on the first part or the second part,
 35 the third part being a locking element movable between an extended position and a retracted position,
 the extended position corresponding to a locked condition of the connection system,
 the first location and the second location being arranged so that when the first
 40 module and the structure are located in the preselected relative positions with respect to each other the first part and the second part are in alignment with each other enabling the fixed engaging element to cooperatively engage with the second part to interconnect the first module and the structure to one another to maintain the preselected relative positions of the first module and the structure with respect to one another to interconnect the first module
 45 and the structure, and
 the movable locking element extends between the first part and the second part to lock the first module with respect to the structure to inhibit relative movement of the first module and the structure.
- 50 According to one form of the present invention there is provided a connection system for connecting a first module to a structure, comprising
 a first part, a second part, and a projection,
 the first part and the second part being separate to one another,
 the first part being adapted for fixed attachment to the first module at a first
 location,

- 4 -

the first part having a fixed engaging element oriented in a first direction,
the second part being adapted for fixed attachment to the structure at a
second location extending outwardly therefrom,
the projection element extending in a second direction,
5 the first direction and the second direction being different directions from one
another,

the first location and the second location being arranged so that when the first
module and the structure are located in preselected relative positions with respect to each
other the first part and the second part of the connection system are in alignment with each
10 other enabling the fixed engaging element of the first part to cooperatively engage with the
second part to interconnect the first module and the structure to one another to maintain the
preselected relative positions thereof to interconnect the first module and the structure, and
the projecting element is located intermediate the first part and second part to
maintain the relative positions of the first module and the structure with respect to one
15 another.

According to one form of the present invention there is provided a building module for
use in constructing a building structure from a multitude of building modules,

the building module comprising
a framework for generally defining the dimensions and configuration of the
20 building module,
the framework having a first set of framework members arranged for
determining the dimension of the building module in one direction by extending from one
part of the building module to another part of the building module, and
a second set of framework members located intermediate the locations of the
25 first set of framework members, the second set of framework members being auxiliary
framework members forming associated framework members,
at least one cover member,
the cover member associated with at least one of the associated framework
members of the second set of auxiliary framework members, and
30 a connecting system for use in connecting the module,
the at least one cover member being made from a generally lightweight
building material,
wherein
the cover member is connected or connectable to the associated framework
35 member, and

the connecting system includes a first connector and a second connector that
are complementary to one another for use in connecting the building module to form the
building structure by cooperatively engaging with a main framework member.

According to one form of the present invention there is provided a connector for
interconnecting a first building module and a second building module, the connector
40 comprising

a projection extending from an upper part of the first building module,
the projection including a body portion and inclined upper portion located
distally of the body portion,
45 a locking arrangement located in or on the body portion for locking
engagement with the second building module,
the locking arrangement including a locking member or element movable
between an locking position and a clearance position,
the locking arrangement being biased so that the locking member or element
50 is in the locking position at rest,
the second building module including a receiver for receiving the projection of
the first building module therein or thereon,
wherein

- 5 -

in response to movement of the second building module towards the first building module, the locking member or element moves from the locking position to the clearance position to facilitate further movement of the second building module with respect to the first building module, and in response to a further movement of the second building module the locking member or element moves from the clearance position to the locking position to interconnect the first building module to the second building module.

According to one form of the present invention there is provided a building structure including a multitude of individual building modules, the building module comprising

a framework for generally defining the dimensions and/or configuration of the building module,

the framework having a first set of framework members arranged for determining the dimension of the building module in one direction by extending from one part of the building module to another part of the building module, and

a second set of framework members located intermediate the locations of the first set of framework members,

at least one of the second set of framework members forming an associated framework member,

at least one cover member,

the cover member associated with the at least one of the associated framework members of the second set of framework members, and

a connector,

the at least one cover member being made from a generally lightweight building material,

wherein

the cover member is connected or connectable to the associated framework member of the second set of framework members, and

the connector is adapted for use for interconnecting the building module to form the building structure.

DESCRIPTION OF EMBODIMENTS

Individual Modules

Individual modules are in the form of modules, cells, pods, assemblies, boxes, rooms, or similar having a metal framework and one or more wall, ceiling, roof or floor made from a lightweight building material.

Building structures includes both modules and solid substrates of the building structures. Typical examples of solid substrates include reinforced concrete structures or components forming the core of the building, such as for example, support columns, lift shafts, pillars, and the like generally made from reinforced concrete.

Although the primary purpose of the connection system of the present description is for interconnecting different individual building modules, typically in the form of individual building pods, to other individual building modules or pods and/or to suitable supporting substrates or solid structures, such as for example, structures made from precast reinforced concrete, typically in the form of the core of a building, lift shafts, shelters, bunkers or similar, it is to be noted that the connection system is useful in interconnecting modules for other purposes, such as for example, forming stacked arrays of shipping containers or other similar modules or where there is a need for similar modules or assemblies to be interconnected together having a requirement that there is no or very limited relative movement of one module with respect to an adjacent contiguous module in any direction or in any manner, including either or both vertically or horizontally.

Although individual building modules can have any suitable, convenient or desired form, shape, style, configuration, size, dimension or similar, forms of the modules are configured in accordance with the design layout of the building structure into which they are to be installed, and accordingly, there are restrictions on the design parameters of the module. In one form the individual module is a box or box like structure having substantially

planar covering or cover members, such as for example, planar outer surfaces, boundaries or walls, a flat ceiling, a flat floor, two flat end walls or sides, and two flat side walls or other sides.

5 Forms of the individual modules have walls, floors or ceilings provided with penetrations, such as for example, openings serving as doorways, corridors, access walkways, escape ports, escape hatches, openings for windows or skylights or similar, openings for services and utilities, such as for example, mechanical, electrical and plumbing services and facilities (MEP), such as power, energy, communications, water, sewage or the like.

10 Although it is preferred that individual building modules be substantially rectilinear, being typically cuboid or generally rectangular, in the form of a rectangular prism, parallelepiped, or similar it is to be noted that in some forms the building module, although less preferred, can have unique designs and have different building features, such as curved facades and/or non-rectilinear or non-rectangular layouts to enhance the ascetic appeal of the building structure and/or to provide architectural features and/or special purpose spaces, 15 such as for example, balconies, outdoor pools, spas, recreation rooms or other wet areas and the like.

Typical examples of the individual building module are in the form of a living room, a dining room, a bedroom, a master bedroom, a bathroom, a kitchen, a utility room, a lounge 20 room, a family room, a recreation room, a toilet, a shower room, a multi-purpose room, a games area or room, a hobby room, a special purpose room or other room.

Forms of the individual building module can be open sided by being provided with a ceiling, a floor and two closed opposed walls, typically closed end walls, with openings 25 corresponding to the remaining two open opposed sides or where side walls would be, if provided, allowing individual modules to be arranged in abutting side by side relationship to each other with the open sides in aligned opposed face to face relationship for forming a large open unencumbered space or area, such as for example, a classroom, hall, nursing home, hospital, dormitory, play room or area or similar by spanning the length of all of the modules in abutting relationship in which the length of the room is greater than the width, 30 preferably much greater than the width in which the length of the room corresponds to the total combined lengths or widths of the modules.

In one form the individual module is provided with an addition or modification to the basic shape of the module, such as for example, the module is provided with a balcony, outdoor area, conservatory, decking, garden area, wet space, pool or other arrangement.

35 In one form the individual module is provided with access openings, typically internal access openings, more typically in the form of inspection hatches, inspection doors, inspection ports or the like for allowing periodic structural inspection of the building structure and of the residential units and of the individual modules, including inspection of the connectors of the connection system for interconnecting individual modules. In one form the inspection openings are strategically located at locations or within areas which are discrete 40 and/or obscured from direct view, such as for example, on balconies, on or in air-conditioning ledges, in ceiling cavities or chambers, in kitchens, in common corridors or other locations which are less inconvenient for occupiers of the residential units and/or building structure.

45 Forms of the module are provided with a ceiling. Some forms of the module are provided with a false ceiling defining a cavity or chamber within which is housed services/facilities, such as for example MEP facilities, such as duct work for air-conditioning and/or heating or the like. In some forms, the cavity or chamber between the false ceiling and the outer ceiling or upper ceiling of the module is a MEP zone (Mechanical, Electrical and Plumbing zone). If a module is provided with a false ceiling the height of the module 50 from the floor to the false ceiling is compliant with all of the requirements of the building code governing the construction of the building structure in the geographical location of the building structure, particularly relating to the height of rooms suitable or required for human habitation.

Framework

Forms of the framework can have any convenient or suitable shape, configuration, size, type, style or the like. In one form the framework is generally rectilinear, typically in the form of a rectangle or square. However, it is to be noted that the shape of the framework generally can have extensions or additions, or a void or deletion such as for example, an additional framework or modification to the basic framework for forming a balcony, a conservatory, an outdoor area, an internal or external wet area, a storage area, and outdoor room or the like.

Generally, the framework consists of a number of individual framework members or sections interconnected to one another to define the shape of the module. In one form the framework is a metal framework consisting of a multitude of interconnected metal framework members or sections in which the framework members/sections are typically made from steel or steel alloys, such as structural steel, including galvanised steel, treated steel, or the like.

In forms of the framework the metal framework sections are welded together, typically heated and welded or the like. However, other forms of the framework include framework members which are interconnected together by being bolted together, having swaged ends, or being interconnected together using contact elements, fittings or fasteners such as rivets, collars, clamps, or the like.

Although any suitable or convenient form of metal section can be used in forming the main, primary or first set of framework members, or framework of the building module, it is to be noted that typical forms, shapes, sections, styles of metal framework members include the following: square or rectangular section tubes, circular or elliptical profile tubes, CHS, RHS, SHS, channel sections such as "C-shaped studs", "H-shaped" sections, "I-shaped" beams or sections, box sections, or the like.

In one form the framework members extend as a single piece having a length corresponding to the distance from floor level of the module to the ceiling level of the module. However the framework members can have any suitable length depending upon the precise location of the framework member, such as for example, a framework member being a column, either an end column or a mid-location column, a beam either an end beam, a mid-location beam, a ceiling beam, a floor beam or other transverse beam. It is to be noted that generally flooring beams have dimensions and strength which are relatively greater than the corresponding dimensions and strength of ceiling beams.

In one form the framework member is a single framework member, two conjoined framework members, three conjoined framework members, four conjoined framework members or similar depending upon the requirements of the building structure, such as for example, the load bearing requirements of the individual building module, such as for example, depending upon the level at which the module is to be located within the high rise building structure. In one form modules located towards the lower levels or base of the building structure have a requirement for increased load bearing capacity whereas modules located at the upper levels of the building structure have a requirement for reduced load bearing capacity, but increased resistance to deflection, flexing, vibration or swaying. Typically, the framework is provided with at least two, preferably more common connection points enabling two or more adjoining modules to be interconnected together, such as for example, including stable common point connection involving the use of columns, collar plates, fasteners, fittings or the like in accordance with the precise location at which the module is to be installed.

Forms of the framework are arranged so as to have the required wind loading to resist excessive swaying or deflection in high winds. In one form individual modules for installation within the building structure at higher levels require increased wind loading resistance whereas modules for installation at lower levels require different wind loading resistance, but increased load bearing strength. Accordingly, the size and gauge of the RHS or SHS used to form the frame is in accordance with the location within the building structure

of the individual module, as well as the size and gauge of the ceiling beams being less and the size and gauge of the flooring beams of the one module.

Although the height of the individual module, and accordingly, the length of the individual framework members in the form of columns or other vertical supports forming the module, can be of any suitable or convenient length, typical lengths are in the range from about 2 m to about 4m, typically from about 2.4m to about 3.6m, more typically from about 2.7m to about 3.3m. The length of vertical columns of the module correspond to the height of the room or area defined within the module formed by the vertical columns.

The dimensions of the metal framework sections can be of any suitable, desirable, or convenient size.

In one form the framework sections are provided with supports for supporting the lightweight infill sheets or panels. In one form the support is a bracket, cleat, tongue, toothed edge, flange, ledge, notch, rebate, groove, channel, or the like.

Forms of the framework have different arrangements of framework members or sections. In one form there is a first set of framework members or sections, and a second set of framework members or sections.

In one form the main framework members or the first set of framework members or sections, typically in the form of columns, more typically tubes or tubular columns, and more typically square section tubes, are located at the corners of the building module in which case the framework members are main members or vertical members or sections. In one form there are main framework members or columns located intermediate the corners of the module, such as for example, at locations part way along the length of the wall or walls, typically at or about the midpoint of the walls of the module, in order to provide increased strength and rigidity to the module. However, columns can be located at any location along the length of a wall or an of the module in substantially parallel spaced apart relationship to one another to provide the required strength and rigidity of the module.

In addition to the main framework members in the form of vertical columns there are main framework members in the form of horizontal beams, joists, bearers, or similar extending between adjacent columns.

The second set of framework members or sections which are secondary or associated framework members are generally in the form of studs, purlins, girts or similar. In one form all of the secondary, associated, axillary or the second set of framework members are arranged in spaced apart substantially parallel relationship to one another, such as for example, all of the auxiliary framework members extend between the ceiling and floor of the module as part of the sidewall or end wall of the module. In forms of the module, some of the framework members extend in one direction and others of the framework members extend in other directions, typically in a perpendicular direction to one another, such as for example, in a grid or grid-like array. In forms, some of the framework members extend substantially vertically whilst others extend substantially horizontally. In forms, some of the framework members are full length members extending from floor to ceiling or from wall to wall or from end to end whilst others of the framework members are part length members extending to a lesser distance than the full length members.

In one form of the individual building module there is a combination of vertically extending framework members and horizontally extending framework members and/or framework members extending in two different vertical directions and/or in two different horizontal directions.

In one form, the second set of framework members, auxiliary framework members or associated framework members are an internal framework comprising a multitude of framework members interconnected to one another to generally define the dimensions, shape and style of the individual building module. Some of the associated framework members or secondary framework members are structural whereas other members are not structural or load bearing, but, typically, are provided for attaching fittings, fixtures and other components thereto.

In one form of the module, there is an internal framework comprising the columns and beams of the first set of framework members and the studs of the second set of framework members, and additionally a further set of framework members being an external or cosmetic framework in which the internal framework provides structural integrity to the building module and allows the lightweight panels to be connected to the module, and the external framework is primarily decorative and/or cosmetic and/or provided to complete finishing of the individual building module, such as for example, to provide for the provision of doors, windows or similar in the walls of the building module and/or to provide architectural features or fittings and fixtures in accordance with the design of the building structure, typically for supporting fittings, fixtures and other componentry of services such as MEP services.

Cover or Infill Panel

In one form the cover or infill of the individual building module is a single skin of lightweight material, or is a double skin or multiple layered skin comprising two or more different layers of materials in accordance with requirements of the building structure, such as for example, materials for providing thermal conductivity, noise control and insulation, fire propagation resistance or the like.

In one form of the module having the material of the different layers are the same, whereas in other forms the various layers are made from different materials having different properties, particularly different thermal transmission properties, heat insulation properties, noise transmission properties, fire retardation properties or similar.

When there is more than a single layer, the additional layer, being the external layer is a facade, covering, capping or similar located on the external face of the wall, or is provided with a surface treatment or decorative treatment to enhance the durability and/or aesthetic appeal of the building module, such as for example, the outer skin being a facade provided with a decorative or ornamental pattern or similar.

Although the lightweight material for forming the walls of the individual building module can be made from any suitable, convenient or desirable material, it is to be noted that a preferred form of the lightweight material is a cementitious material or cement-like material or a concrete-like material or a concrete substitute material. In one form the lightweight material is a combination of different types of lightweight materials, including unreinforced materials or reinforced materials.

A preferred form of lightweight material is autoclaved aerated concrete (AAC) including both non-reinforced and reinforced material. More preferably, the AAC is manufactured by CSR Building Products Limited and marketed under the trade name "HEBEL".

The AAC material is in the form of reinforced sheets, panels, blocks, slabs, planks, lengths or similar. The reinforcement can have any suitable or convenient form including linear forms, rectilinear forms, cages, sheets, mesh or curved forms. Forms of the panels or slabs can be provided with tongue and groove arrangement along longitudinal sides or edges to assist in joining the panels to one another to form a more or less continuous surface.

Although the AAC sheet or panel can have any suitable or convenient dimension, the size of the sheet is in accordance with the size of the framework of the module so that the sheet or panel can be readily fixed to the framework, preferably, without having to cut the sheet or panel to size to fit the framework to form a wall or the ceiling or floor of the individual module, particularly in the lengthwise extending direction of the panel. In one form the wall or walls and/or ceiling are panels of AAC and the floor is a slab of AAC. Depending on where the AAC panel or sheet is to be located, the panels or sheets have different thicknesses such that a ceiling panel is of a relatively thinner thickness, typically about 100 mm thickness, than that of a flooring panel which is typically about 150 mm thickness. Walls can have thicknesses of from about 75 mm to greater than 300 mm, typically nominally from 150 to 300mm.

- 10 -

Although the thickness of the panel of AAC can be any suitable or convenient thickness, typical thicknesses are from about 35 mm to about 300 mm or more, more typically in the range from about 45 mm to about 200 mm, even more typically in the range from about nominally 50 mm to about nominally 150 mm, and most preferably nominally about 50 mm or nominally about 100 mm or nominally about 75 mm. it is to be noted that panels installed as flooring panels, ceiling panels or wall panels have different thicknesses to one another.

Although the width of the AAC panel can be any suitable or convenient width, it is preferred that widths be up to about 900 mm, more preferably in the range from about 200 mm to about 700 mm, even more preferably in the range from about 300 mm to about 600 mm, and even more preferably having a nominal width of about 300 mm, of about 450 mm, of about 600 mm.

Although the length of the AAC panel can be any suitable or convenient length, typical lengths are in the range from about 1.8 meter to about 4.2 meter or more, even up to about 6 meter. More typically, the length is in the range from about 2.2 meter to about 3.6 meter, even more typically in the range from about 2.4 meter to about 3.2 meter, preferably in the range from about 2.7 meter to about 3.2 meter with typical lengths being nominally 2.2 meter, 2.4 meter, 2.7 meter, 3.0 meter, 3.2 meter, 3.3 meter, 3.6 meter or the like.

In forms of the building module the infill panel or facade or similar or both is/are fixedly attached to the metal framework members, typically directly attached, more typically using suitable fasteners. Typical fasteners include staples, bolts, screws, nails, clips, brackets, rivets, or the like. Forms of the module have walls, ceilings and/or flooring of individual panels grouted or similar together using suitable grout, cement, adhesive, glue or the like to form a smooth more or less continuous external surface.

Preferably, the panels are attached to the outside or outer surface or exterior of the metal framework members so that the metal framework members are obscured from view outside of the building module.

Forms of the material from which the second or subsequent layer of the skin of the module, typically the exterior layer or surface, more typically in the form of a facade, can be manufactured include materials such as glass fibre reinforced materials, or the like.

Connectors

The purpose and/or function of the connectors of the connection system of the present description is to join individual building modules or pods to other parts of the building, which includes structures such as for example, to other individual building modules or pods or to suitable supporting substrates, such as for example, parts of the structural framework of the building, including solid substrates or structures, precast reinforced concrete structures, typically in the form of ceiling slabs, flooring slabs, support columns, shafts, stairwells, lift wells, bunkers, safety enclosures or shelters and the like. The connection system includes one or other type of connectors or combinations of respective connectors, including two different complementary connectors. It is to be noted that the connectors can take a variety of different forms, shapes, configurations, types, sizes or styles depending upon requirements such as whether two individual pods are to be connected to one another or whether an individual pod is to be connected to a supporting substrate in the form of a structural part of the building.

Forms of the connectors include connectors having two different parts, typically two different parts which are complementary to one another, typically two parts which cooperatively engage with each other. In one form one part is a male part having one or more projections, typically in the form of protrusions, plugs, projections, bosses, extensions, pins, pegs, rods, spigots, or similar, and the other part is a female part, typically in the form of a receiver, receptacle, or similar having one or more voids, cavities, spaces, gaps, chambers, grooves, channels, sockets, collars, rims or the like. When two adjacent modules are located in the correct position with respect to each other the two parts of the connectors

are in alignment allowing the projection of one part of the connector to be received in the receiver of the other part of the connector to interconnect the modules.

In one form the first part or male part is a tube, typically a main tube, more typically an open ended main tube, and more typically a double open ended main tube. In one form the hollow tube is a short length of tube having a square or rectangular profile, cross-section, or shape. In one form the short main tube is provided with an auxiliary projection, typically located or secured to one side wall of the main tube. In one form the auxiliary projection is solid whereas in other forms the auxiliary projection is hollow or tubular, preferably a square section or rectangular section tube, including a section of constant dimensions over the length or a section having variable dimensions over the length, such as for example a wall or side being tapered, bevelled, sloping or similar. In one form the direction of extension of the auxiliary projection is different to the lengthwise extending axis of the main tube. In one form the direction of extension of the auxiliary projection is substantially perpendicular to the central longitudinal axis of the main tube. In one form, the main longitudinal axis is substantially vertical whereas the axis of the auxiliary tube is substantially vertical. In one form the auxiliary projection is a stop member or element for controlling movement of the building product when cooperatively engaging with another building pod or solid substrate of the building.

In one form the main tube is provided with an opening, aperture, or similar located in the side wall of the tube, typically in the outwardly facing side wall of the main tube opposite to the side wall which is attached to the beam, typically the flooring beam of the individual building module or pod. Although the aperture can have any suitable size, shape, profile, or similar it is to be noted that a preferred shape is circular, typically for receiving a fastener therein or there through. In one form the fastener is a bolt or has a cylindrical shaft. In one form the fastener has a threaded distal end in which the distal end is received in or through the aperture of the main tube. A suitable fitting is threadingly engaged on the threaded distal end of the fastener. In one form the fitting is a nut, typically a hexagonal nut.

The connection system includes a second part. Although the second part can have any suitable or convenient form, one preferred form is provided with an anchoring portion and a guiding portion. In one form the guiding portion extends outwardly from the anchoring portion.

In one form the anchoring portion is located at or towards the proximal end of the connector in use. In one form the second part of the connector is provided with two anchoring portions. In one form the anchoring portion is a planar member, typically in the form of a plate. In one form the plate is a square or rectangular plate, more typically having an aperture or opening, even more typically a centrally located circular hole.

Preferably, the anchoring portion includes two plates angularly inclined to one another and joined to each other along abutting common edges. More preferably, the plates are joined to one another substantially at right angles so as to form a right angled corner. In one form the plate or plates of the connector are for location within or ends, spaces, rebates or similar in the solid concrete support structure of the building, most notably the solid ceiling slab.

Although the guiding portion can have any suitable or convenient form, shape, profile, style or similar, it is to be noted that the form of the guiding portion corresponds to the form of the fastener. Preferably, the guiding portion is a guide, typically in the form of a tube, bore, sleeve, collar, or similar having an opening, aperture, bore or the like. Preferably the guide is a cylindrical hollow tube of a size for receiving therein and/or there through the cylindrical shaft of a bolt, typically a high tensile bolt. In one form the respective axes of each guide tube are arranged substantially perpendicular to each other.

In use, the plate of the anchoring portion anchors the connector to a precast reinforced concrete slab having voids. The plates are received within the void, typically in the form of an L-shaped void, opening, cut-out, space or gap in order to precisely locate the connector with respect to the structure. In this orientation the elongate hollow tube extends to the edge of the structure adjacent the circular opening of the first part of the connector

and in alignment there with so that the distal end of the threaded bolt received through the guide bore extends into and through the aligned opening where the bolt can be secured by a suitable received on the end of the bolt. A second bolt is received through the circular bore of the elongate guide tube so that the distal end thereof extends through the aligned circular opening of the first part of the connector of a second or subsequent building module or pod to securely interconnect the second pod to the structure.

Alternative forms of connectors of further connecting systems also include a first part in the form of a male member and a second part in the form of a female member. In one form the first part is a projection, typically in the form of a plug, spigot, pin, post, peg, or other substantially elongate member. Typically, the spigot is tubular or hollow, preferably of a square or rectangular profile or cross section. More typically, the spigot has an open end, preferably two open ends. Forms of the spigot are double ended in which one end is received in one column being the column of a lower module and during installation of the module the other end is received in another column being the column of an upper module so that the spigot interconnects the upper and lower columns and hence the upper and lower modules. Forms of the spigot are attached to the columns at the manufacturing facility whereas other forms of the spigot are securely attached to the columns at the building site prior to installation of the module, or alternatively after the module has been installed within the building structure. Forms of the spigot are securely attached to the columns by any suitable or convenient form of welding, adhesives, interference fit, or similar. In one form the spigot is a slide fit spigot received within the open bore of the column.

In one form the spigot has a proximal portion in the form of a body and a distal portion in the form of an end portion. Typically, the end portion is an upper portion extending substantially vertically upwards from a column of the pod. Typically the upper portion is received in the lower end of the column of the upper module. Typically, the body portion of the spigot is of constant size or cross section whereas the distal portion is of reduced size compared to the size of the body of the spigot. In one form the distal portion is tapered, bevelled, conical, or of any suitable shape or profile of reduced dimensions including reduced diameter or reduced width. The taper of the spigot allows or facilitates entry of the spigot into the receiver portion of another pod, such as the floor beam of another pod, typically an upper pod in which the receiver portion extends outwardly from the floor beam. More usually, the tapered end of the spigot is received within the rim, collar or lower end of the column of an upper pod.

A lifting bracket or suitable lifting fitting extends outwardly through the opening at the open end of the tapered distal portion of the spigot, typically the upper end in use of the spigot, for facilitating lifting of a pod using the columns of the pod. In one form the lifting bracket is provided with an aperture for receiving there through a part of the lifting device such as for example a hook, cable, chain, or similar. The lifting bracket or fitting can be permanent remaining attached to the spigot during installation and use of the pod whereas the lifting bracket or fitting is removable after the pod is hoisted into position.

In one form the body portion is provided with a locking member, typically a movable locking member which is movable between a retracted position and an extended position. It is to be noted that when the movable locking member is in the extended position the spigot is locked in position with respect to the receiver of the second part of the connector of the connecting system. More typically, the locking member is biased to be in the extended position at rest in which the locking member extends outwardly from a side wall of the tubular body of the spigot. In one form the bias is provided by a spring bias or a resilient bias for maintaining the locking member in the extended position when at rest.

In operation, the locking member is pushed movably inwards to the retracted position when the upper pod is being lowered onto the upwardly extending spigot of the lower pod by the female part of the connection system being secured to the upper pod, typically to the floor beam of the upper pod, and more typically extending outwardly from the floor beam of the upper pod, or even more typically being the rim or collar of the open lower end of the column of the upper pod. When the aperture or slot or opening of the second part of the

connection system, being the female part, is aligned with the position of the locking member, the locking member is free to move under the effect of the biasing element to the extended position to lock the upper and lower pods to one another. Preferably, the locking member is a latch or latch bolt or similar. More preferably the latch or latch bolt is spring loaded. In one form the latch or latch bolt is provided with a sloping, tapering or bevelled surface facilitating sliding movement of the latch from contact with the female portion, typically in the form of a socket, collar or the rim of an open tube.

Forms of the connector are provided with two locking members, preferably located in opposed relationship to one another so that one locking member is located on one side wall and the other locking member is located on the other side wall of the spigot. In one form the two locking members are arranged so that the movable latch of each respective locking member moves in the same plane of movement but in opposite directions from the respective retracted positions to the respective extended positions.

Forms of the connector are made from any suitable or convenient material, such as for example preferably metal, including alloys or combinations of different materials including different metals or metallic materials.

Forms of the connection system include a joiner for interconnecting two columns or two spigots of adjoining modules or pods. The joiner, typically in the form of an interlocking joiner contributes to secure location of the pods with respect to one another preventing lateral movement of one pod with respect to another pod or of one pod with respect to the solid substrates of the building structure. One form of the joiner is a plate, including a connecting plate, melding plate, mending plate, shear plate, shear interconnecting plate, collar plate, or similar. Forms of the plate include apertures or holes, in which the apertures are typically in aligned side-by-side relationship to one another having a spacing apart corresponding to the spacing apart of two contiguous spigots attached to different adjoining modules or in offset or off-centred side-by-side relationship for receiving there through spigots in corresponding offset or off-centred side-by-side spaced apart relationship to one another. It is to be noted that the joiner or shear interlocking plate is located at and forms one of the common connection points interconnecting two adjacent modules.

In one form the plate is of a rectilinear shape, typically a square or rectangular shape, and more typically has a thickness in the range of 10mm to about 50mm, more typically in the range of 15mm to about 40mm, preferably in the range 18mm to 30mm, more preferably about 20mm.

In forms, when individual building modules are located in their respective final positions within the building structure in side-by-side relationship with an adjacent building module, there is a gap, typically a small gap, between the respective outer surfaces of the walls of the respective modules. In one form the gap between two adjacent modules is in the range of from about 2 mm to about 100 mm, typically in the range from about 5 mm to about 50 mm, more typically in the range from about 7 mm to about 30 mm, preferably in the range from about 8 mm to 20 mm, most preferably nominally about 10 mm. However, it is to be noted that the spacing between adjacent modules can be any suitable spacing depending upon requirements.

In one form, the distance from the inner surface of the interior wall of one module to the inner surface of the interior wall of an adjacent module at the same level within the building structure is in the range from about 250 mm to about 600 mm, typically in the range from 300 mm to 500 mm, preferably in the range of from about 300 mm to 400 mm, more preferably nominally about 360 mm.

In one form modules are placed with a space or open area located there between. In one form the space or open area is a corridor, passageway, hall or similar thoroughfare allowing movement from one module to another module or to gain access to the outside of the module, such as for example, to an outdoors area defined within a balcony or similar of the residential unit.

In forms, the connector is provided with a dampening component for reducing the transmission of vibration through the connector and/or module when the vibration is caused

by noise, sound, impact, drumming or similar. In one form the dampening component is a layer, a pad, a tile, a square or similar, typically made from a resilient material, to dampen the amplitude and/or frequency of vibration being transmitted from one module to another module, typically by and/or through the connector for interconnecting the modules together.

5 In other forms, the dampening component is a strip of resilient material located in the gap or space between two adjacent modules. Examples of the resilient material include foams, including open and closed cellular foams or the like.

The individual building modules, when placed in their final location, are attached to the core of the building structure by suitable or convenient fixing means using suitable fittings and/or fixtures. In one form the fixing means includes mechanical fasteners such as bolts, or the like, chemical fasteners such as adhesives, grout, or the like, or combinations of both mechanical and chemical fasteners.

10 Although any suitable attachment arrangement can be used, typically the individual building modules are attached, either directly or indirectly, to the reinforced concrete core of the building structure using pins, bolts, or other mechanical fasteners. Typical examples of the fixing arrangement for attaching the module to the core include mechanical fasteners.

Residential Units

20 In one form the living or dwelling space forming the residential unit comprises multiple individual different building modules, such as for example, separate modules being in the form of a living and dining room (LRDIN), a main bedroom with optional en-suite bathroom, a kitchen and a second bedroom with optional bathroom or the like.

Although there can be any number of different modules forming the residential unit, the number of individual building modules will vary depending upon the type of residential unit required and the form and style of the building structure. Typically, the number of different individual modules comprising a living space of the residential or dwelling unit will be in the range from about 1 to about 10 or more individual building modules. In one form all of the individual building modules are different from one another whereas in other forms there may be more than one of a single individual building module of the same type of module, such as for example, 3 or 4 substantially similar bedroom modules, two or more bathroom modules or the like.

30 Although the description will be directed primarily to residential units, it is to be noted that the individual building modules can be configured for a wide range of different purposes, such as for example, a dormitory, workers accommodation, hospital, nursing home, school, emergency accommodation, old aged care facility, temporary shelter for shorter or longer periods in times of disasters, natural catastrophes or the like.

In one form the layout of the residential unit, the lengthwise extending axes of individual modules are arranged to extend in substantially parallel relationship to each other so that all of the modules are aligned with each other, whereas in other forms of the layout of the residential unit, there is a mixture of orientations of the modules, such as, the lengthwise extending axes of individual modules being arranged to extend substantially perpendicularly to one another, including for example, the living/dining room module and multiple bedroom modules may have longitudinal axes substantially parallel to one another and the lengthwise extending axis of the kitchen module or of a balcony module or similar extending substantially perpendicular to the other longitudinal axes. However, it is to be noted that any layout or arrangement of individual modules is possible, including modules being angularly inclined to one another.

45 Forms of the modules are provided with floor coverings or flooring finish over the flooring panels. Floor coverings or finishes can be any suitable or convenient form, type, style, material or the like.

50 In one form of the layout of the residential unit there is an internal wall provided within an individual module. In one form the internal wall is a non-structural wall or non-load bearing wall such as a partition wall, separating wall or dividing wall. Typically, the partition wall is a demountable non—structural partition wall, more typically manufactured from dry

wall sheets, boards, panels or the like, including plasterboard, gypsum board, magnesium board, fire resistant panels, sheets, boards, water resistant panels, sheets, boards or similar.

Forms of the residential unit, and of the individual building module are provided with weather proofing or weather resistance and/or water drainage or similar for preventing unwanted accumulation of water leading to deterioration of the building module, the residential unit and/or the building structure due to the build-up or pooling or ponding of water, moisture, humidity, condensation, or similar.

BRIEF DESCRIPTION OF DRAWINGS

Embodiments of individual building modules, of arrangements of various forms of connectors, of layouts of individual building modules forming residential units, and of building structures comprising a multitude of residential units will now be described by way of examples illustrating aspects of the present description with reference to the accompanying drawings in which

Figure 1 is a schematic top perspective view of one form of a layout of a dwelling formed by multiple individual building pods interconnected together.

Figure 2 is an exploded schematic top perspective view of one form of one building module showing the relationship of the component parts to each another.

Figure 3 is a schematic top perspective view of forms of the building pod in spaced apart relationship to one another prior to being joined together.

Figure 4 is a schematic top view of forms of individual building pods arranged in side by side joined relationship and in stacked relationship one upon the other.

Figure 5A is an enlarged schematic top perspective view of one form of connector in the form of a spigot.

Figure 5B is an enlarged schematic top perspective view of two individual spigots of figure 5 in conjoined relationship for interconnecting two adjacent building pods together.

Figure 6 is an enlarged view of one form of a fastener for attaching individual AAC panels to the framework of the pod to form a wall of the building pod.

Figure 7 is a schematic side perspective view of one form of spigot shown in isolation.

Figure 8 is a cross-sectional view of the spigot of figure 7 showing details of the locking arrangement located within the spigot.

Figure 9 is a schematic cross section view of another form of spigot having another form of locking arrangement shown in situ for interconnecting an upper building pod and lower building pod for preventing vertical and horizontal relative movement of the pods.

Figure 10 is a schematic top plan view of the floor of one form of building pod showing details of the internal construction of the building pod and of the external covering forming a facade of the building pod.

Figure 11 is a schematic cross-section view along the line A to A of figure 12.

Figure 12 is a schematic cross section view along the line D to D of figure 12.

Figure 13 is a schematic cross section view along the line F to F of figure 12.

Figure 14 is a schematic cross section view along the line B to B of figure 12.

Figure 15 is a schematic cross section view along the line D to D of figure 12.

Figure 16 is a schematic top plan view of another form of joiner having offset apertures for joining two building pods in side by side abutting relationship to one another for preventing relative movement of one another.

Figure 17 is a schematic perspective view of one form of spigot encased within a covering of cementitious material.

Figure 18 is a schematic exploded perspective view of one form of connection system having complementary cooperatively engaging parts.

Figure 19 is a schematic perspective view of another form of connection system having cooperatively engaging parts shown in isolation.

Figure 20 is a schematic perspective view of the form of the connection system are figure 19 shown in situ for conjoining two adjacent building pods together.

DESCRIPTION OF SPECIFIC EMBODIMENTS

Forms of building modules for use in prefinished prefabricated volumetric construction (PPVC) for forming building structures will now be described.

5 In figure 1 is shown schematically a typical multi room dwelling unit or apartment, 10, constructed from multiple different individual building pods, generally denoted as 12, which pods can have any size, shape, design, function or the like. Additionally, the dwelling apartment or unit can be of any size, configuration, design or similar.

10 In figure 2 is shown schematically in exploded form one form of an individual pod 12 which includes a flooring framework 14, flooring of individual panels of autoclaved aerated concrete (AAC) 15, a ceiling of individual panels of AAC 115 in which the flooring panels 15 are supported by flooring framework 14, spanning from one longitudinal side of pod 12 to the other longitudinal side. Flooring framework 14 includes flooring beams 16 provided along either long side of pod 12 to form longitudinal beams and along either short side of pod 12 to form transverse beams 17. In one form flooring beams 16 and transverse beams 17 are 15 RHS sections or box sections. Columns 18 extend substantially vertically from flooring beams 16 and transverse beams 17 to provide support for the ceiling and walls of pod 12 and provide structural strength and rigidity for pod 12. In one form columns 18 are RHS sections. The ceiling framework includes longitudinal ceiling beams and transverse ceiling beams 116 arranged generally perpendicular to one another at the one level to form the support for the ceiling of the pod. In one form ceiling beams 116 are I-beams, box sections, SHS sections, RHS sections, or similar. AAC panels 115 form the ceiling of an individual pod whereas AAC panels 20 form the walls of pod 12 and extend between selected columns 18. AAC panels forming the wall which are typically 300mm thick are attached to the framework 25 members of the pod including ceiling beams 115, flooring beams 16, 17 and columns 18 by suitable fasteners, including cleats, clips or similar 19. Forms of pod 12 are provided with the reinforcement, typically in the form of one or more braces, struts, gussets, stays, guys, cross braces or the like including diagonal braces 13 extending from one transverse side to one longitudinal side or the like to enhance the strength and rigidity of the pod. Typically diagonal 30 braces 13 are provided as part of the floor framework of the pod. However, it is to be noted that braces 13 can be provided as part of the ceiling framework either as an alternative to being provided as part of the flooring framework, or in addition to the flooring framework containing braces. It is to be noted that as many braces 13 are provided as necessary or as required depending upon the location of the individual module or pod within the building 35 structure.

One form of the building structure has two individual pods 12 arranged in stacked relationship one above the other. The relationship between the upper pod and the lower pod is shown in figures 10 to 15 in which figure 10 is a top plan view of the floor of the upper pod showing the construction of the flooring using floor panels 15 located intermediate 40 longitudinal flooring beams 16 and transverse flooring beams 17. Optionally, a flooring covering, typically in the form of a flooring finish 21 is provided over the upper surface of flooring panels 15, as shown more particularly in figures 11 to 15 which illustrate the relationship of the floor of an upper pod in vertically stacked relationship to the ceiling of a lower pod showing a space or gap there between as well as the floor beam 16 being in the 45 form of a box channel and the ceiling. Beam being in the form of an I-beam. However it is to be noted that ceiling beam 116 can be a box channel, such as a SHS or RHS. Suitable fittings in the form of brackets, ledges, plates, flanges, ribs, or the like are provided to support the flooring panels and ceiling panels is illustrated in figures 11 to 15.

One form of connector forming the connection system is provided at the upper end of 50 each column 18 for cooperatively engaging with the flooring or connectors, typically connectors attached to the flooring beams 16, 17 of an upper pod being located at a level above the level of pod 12, or engaging with the lower end, such as the rim or collar of the open end of the column of the upper pod. In one form the connector is a spigot (to be described in more detail later). Pod 12 is provided with walls. The AAC wall 20 of pod 12 is

either a single AAC panel extending between adjacent columns 18 or a multiplicity of individual panels arranged in substantially parallel side by side abutting relationship to one another to extend parallel to column 18 extending between ceiling beam 116 and floor beam 16. Optionally, the individual panels are sealed with a suitable sealing agent, such as for example, a paste or gel in the form of a grout, a glue, an adhesive, a cement, or similar. The wall panels optionally have a penetration to receive a building component, such as a window, door, or similar depending upon the function of the pod and the location within the dwelling unit of the pod. Wall panels 20 are attached to the framework of the building pod, typically to the longitudinal beams 16 and transverse beams 17, as well as to selected columns 18, and optionally to ceiling beams 116 by suitable fasteners which include cleats 19, clips, brackets, staples, or the like, as shown more particularly in figure 6.

One form of the connecting system now be described with reference to figure 18. Flooring beam 16 of pod 12 is provided with one part of a connector of this form of the connection system, namely a connector having a female part 22 for receiving part of the complementary male part of the connector of this connection system. In one form the female part is a short length of tube 24 having an open upper end and an open lower end. In one form the tube 24 is of a square section and is welded to flooring beam 16. An opening 26 is provided in the wall of tube 24 for receiving therein a suitable fastener to interconnect the two adjacent modules or of the module to a solid substrate, typically as will be described in more detail later.

The complementary male part, generally denoted as 28, of the connector is associated with the reinforced concrete structure of the building such as the concrete reinforced floor of the building, typically in the form of a slab. The structure is in the form of a slab of reinforced concrete 30 located at a lower level of the building below the level at which pod 12 is to be installed. A generally L-shaped cavity is formed in the upper surface of slab 30 for receiving therein a part of the male connector.

In one form the male connector 28 includes two plates 34 joined substantially perpendicularly along respective side edges to form a generally L-shaped bracket. A guide in the form of a hollow cylindrical tube 36 extends from one plate 34 in a first direction and a further guide in the form of a hollow cylindrical tube 36 extends from the other plate 34 in a direction substantially perpendicular to the first direction. Tube 36 forms a guide for guiding and directing movement and location of a suitable fastener, typically a high tensile bolt 38, for cooperatively engaging with female part 22, particularly opening 26 for interconnecting pod 12 to slab 30. Similarly, a high tensile bolt is received through tube 36 and guided for cooperative engagement with a suitable female part or receiver on another pod positioned against the adjacent edge of slab 30.

In use, when pod 12 is located adjacent slab 30 with female part 22 in the correct position with respect to the location of male part 28, aperture 26 is aligned with the end of tube 36 enabling bolt 38 to interconnect both parts of the connection system.

Another form of connector forming a connection system is illustrated in Figures 19 and 20, and is generally denoted as 40 which connector include two complementary parts, namely being a male part, generally denoted as 42 in the form of a short length of generally square section tube 44 welded to the end of an extension arm 46 extending outwardly from floor beam 16 of pod 12 or from the floor beam of another pod, depending on the spatial relationship of the pods to one another for interconnection of the two pods together. The other complementary part of connection system 40 is a female part 48 in the form of a generally square section socket or collar 50 located at the distal end of extension arm 52 extending from a part of a pod, such as for example, flooring beam 16 of a pod or from column 18 of the pod. In operation, square section tube 44 is located above socket 50 so as to be superposed over socket 50 whereupon when the pod is lowered the short length of tube 44 is received internally within socket 52 to interconnect the two pods together.

Another form of connection system will now be described with particular reference to figures 5A to 9, 16 and 17. The connector of this form of connection system, includes a first part, namely a projection, typically in the form of a spigot, generally denoted as 60. Spigot 60

- 18 -

has an elongate body portion 62 of generally square cross section which body portion is securely attached to or received within the top of column 18 of a pod. It is to be noted that the dimensions of body 62 of spigot 60 are slightly less than the corresponding dimensions of the internal bore of the RHS forming column 18 so that body 62 can be received internally within the bore of hollow column 18 for secure attachment thereto in any suitable or convenient manner, including welding 63, adhesive, swaging, interference fit or the like. Alternatively, spigot 60 is formed integrally with column 18 by being formed at the top of column 18 by any suitable means, such as for example, hot rolling or cold forming of the metal from which column 18 is made so that body portion 62 is formed integrally with column 18. However, it is to be noted that even if body portion 62 is formed integrally with column 18 the dimensions of the outer walls of body portion 62 are less than the dimensions of the inner walls of corresponding column 18 so that spigot 60 can be received within column 18 to anchor spigot 60 securely within column 18 by the external walls of body portion 62 being in intimate contact with the internal walls of column 18, as shown more particularly in figure 9 which also shows the upper end of spigot 60 being received within the lower end of column 18 of the upper pod and the lower end of spigot 60 being securely attached to column 18 of the lower pod by welding 63.

In either form spigot 60 is located at, or extends vertically upwards from, the top of column 18 as shown more particularly in figures 7 to 9 and 17, and has reduced dimensions such as a reduced width spigot 60 is provided with a tapered distal portion 64 or upper portion of a generally square shape. Optionally, tapered distal portion 64 is provided with a flat top surface 65 to which is attached, or alternatively with an aperture 66 through which extends, a suitable lifting element, typically in the form of a lifting bracket 68, having an eyelet 69 through the end thereof for receiving part of a lifting device, such as for example, a hook, cable, chain, rope or similar fitting for facilitating hoisting of the pod into place during construction of the building structure. In one form the lifting bracket is permanently fixed in place whereas in other forms the lifting bracket is removable after the pod has been positioned within the building structure.

It is to be noted that spigot 60 can be attached to column 18 in the manufacturing facility or at the building site either prior to or after installation of the lower individual building module.

A locking arrangement is provided at or towards the upper part of the square section body portion 62. Although the locking arrangement can have any suitable or convenient form, in one preferred form, the locking arrangement includes a movable locking member, typically in the form of a latch or latch bolt 72, more typically a spring loaded or spring biased latch or latch bolt, capable of movement between a retracted position in which latch bolt 72 is received substantially internally within body 62 of spigot 60 and an extended position in which latch bolt 72 extends substantially outwardly from the wall of body portion 62. The latch is biased to adopt the extended position at rest so that the distal end of latch bolt 72 extends outwardly from the side surface of the body portion 62 of spigot 60 prior to cooperative engagement with a column of another pod which is an upper pod, typically the lower end of column 18 of the upper pod.

One form of biasing means is a spring 70 having two generally vertically oriented leaves or arms 73 arranged in a bifurcate configuration with the upper distal ends of leaves or arms 73 diverging away from the lower conjoined or common end 75. In one form spring 70 is provided with an auxiliary spring 77 extending directly between opposed latch bolts 72. In one form the latch 72 is provided with a sloping or a tapering or bevelled surface or part 74 to assist in moving the latch from the extended position into the retracted position during installation of an upper pod on top of a lower pod as the upper pod is lowered onto the spigot of the lower pod.

In operation, the vertical framework member or column 18 of the upper pod is provided with a receiver 78. In one form receiver 78 includes a rim or collar located or formed at the open end of column 18 and one or more apertures 79 in the side wall thereof. If two apertures are provided the apertures are located in the side walls of a lower part of

column 18 on opposite sides of square section column 18 at or towards the lower end in use of column 18 so that lowering of the upper pod enables the rim of the receiver of the upper pod to engage with spigot 60 of column 18 of the lower pod to guide the position and movement of the upper pod onto the lower pod whereupon contact of the rim of the receiver on the tapering surface 74 of latch bolt 72 of spigot 60 attached to the lower pod moves latch bolt 72 inwardly to provide sufficient clearance for column 18 of the upper pod to slide over spigot 60 of the lower pod until aperture 79 is aligned with latch bolt 72 whereupon latch bolt 72 is released to move outwardly to be received fully through aligned aperture 79 to lock the upper pod in position on the lower pod with the distal portion 64 of spigot 60 securely located in the lower end of column 18 of the upper pod, thereby interconnecting the two pods together for inhibiting relative movement of one pod with respect to the other pod to assist in preventing lateral movement of one pod with respect to the other pod, typically relative vertical movement.

In one form a joiner is provided for joining adjacent pods to one another to assist in inhibiting lateral movement of one pod with respect to the adjacent pod. The joiner can have any suitable or convenient form. In one form the joiner is a shear interlocking plate or collar plate or connecting plate 80, a melding plate, a mending plate or spacer. Although the joiner can have any suitable or convenient shape, the joiner is provided with a pair of substantially square section apertures or holes 82 arranged in side by side relationship. In one form the two apertures or holes 82 are aligned collinearly, whereas in another form the two apertures or holes 82 are located off centre from each other or in staggered relationship to one another. Connecting plate 80 is located intermediate the upper end or top of lower pod and the lower end or base of upper pod to join two adjacent pods in side by side abutting relationship to one another to assist in securely interconnecting the pods to one another to prevent or inhibit lateral relative movement of the two pods with respect to one another in one or both lateral directions so as to ensure the pods remain in the correct location within the building structure throughout occupation of the building structure. It is to be noted that connecting plate 80 is installed in position over the pair of spigots 60 prior to lowering of the upper pod onto the lower pod. Optionally, a spacer, typically made of a resilient material for inhibiting transmission of vibration is placed over connecting plate 80 during installation of the upper pod over the lower pod.

In one form column 18 having spigot 60 extending upwardly from the upper end in use is encased in a covering or lagging material, such as for example, concrete, AAC, or other cementitious material 86, as shown more particularly in Figure 17. Further, it is to be noted that the external dimensions of body portion 62 is maintained less than the internal bore of column 18 so that spigot 60 is of a size that can be received internally within the internal bore of column 18 during installation of the upper pod over the lower pod.

It is to be understood that, if any prior art publication is referred to herein, such reference does not constitute an admission that the publication forms a part of the common general knowledge in the art, in Australia or any other country.

In the claims which follow and in the preceding description of the invention, except where the context requires otherwise due to express language or necessary implication, the word "comprise" or variations such as "comprises" or "comprising" is used in an inclusive sense, i.e. to specify the presence of the stated features but not to preclude the presence or addition of further features in various embodiments of the invention.