# MODULAR CONCRETE BUILDING SYSTEM

## Technical Field

The present disclosure generally relates to a modular concrete building component and a method of assembling thereof. In particular, the present disclosure relates to a modular concrete building component for use as part of the structure of a building.

## Background

Concrete is ubiquitous in modern day society as one of the world's foremost consumed materials. In particular, concrete structures dominate our planet in the form of skyscrapers, bridges, roads and residential dwellings. However, concrete is also one of the world's greatest carbon dioxide emitters and is responsible for about 7% of carbon emissions globally. Cutting down these emissions is difficult, given the majority arise from the manufacture of concrete itself. As such, the greatest reduction in carbon emissions will come from reducing the amount of concrete material being used, and thus produced. However, reducing the amount of concrete material used in construction without reducing the strength and durability of the resulting structure is non-trivial.

To ensure that concrete structures are sufficiently robust, it is necessary to reinforce the concrete using either passive reinforcement or tensioned steel strands of bundles of high strength wires known as tendons or strands. It is called Reinforced Concrete (RC) when passive reinforcement is used within the concrete however the structural thickness will be higher than the use of tendons. Application of tension to the strands/tendons is called pre-stressing and this technique will reduce the overall amount of the concrete compared to the equivalent RC structure.

There are two main types of tensioning techniques used in the art: pre-tensioning and post-tensioning. Both pre-tensioning and post-tensioning methods produce "prestressed" concrete. This process (i.e. pre-compression) enhances the strength of the structure which makes it highly suitable for construction processes where high tensile strength is required, e.g. building and bridge construction.

Pre-tensioning is a method whereby concrete is cast around strands that have already been tensioned within a bed before concrete is introduced. Typically, the strands are provided in a

linear arrangement, extending between two end anchorages. However, deviators can be used to provide a non-linear extension of the strands across the concrete bed. After the tensioning, concrete is poured into the bed and allowed to harden around the pre-tensioned strands. Then, once the concrete is sufficiently hard, the strands are cut at the anchorages such that the tension force is transferred to the concrete as compression by friction. Pre-tensioned concrete is therefore most commonly used for the production of structural beams, floor slabs, hollow-core planks, balconies, lintels, driven piles, water tanks and concrete pipes.

On the other hand, post-tensioning is a method whereby tension is applied to the tendons after the concrete has hardened. Typically, concrete is poured, and allowed to harden, around ducts that contain strands. Once the concrete is sufficiently hard, tension is applied to the strands such that the tendons exert forces onto the concrete. After the tensioning, grouting material is injected into the duct to fix the tendon in place and bond the strands to the duct (and thus the concrete). Prestressed elements (e.g. slabs) produced using post-tensioning are typically thinner, with superior strength and can span greater lengths than reinforced and prestressed elements (e.g. slabs) provided by pre-tensioning due to continuity and larger drapes. As such, post-tensioned concrete is often preferred over reinforced and pre-tensioned concrete for projects such as skyscrapers and bridges where the distance between the supports may be greater than can be spanned by reinforced and pre-tensioned slabs. This allows large open-plan spaces to be designed that cannot be achieved using reinforced and pre-tensioned slabs.

In addition to the type of reinforcement method used, the concrete used in construction may be either pre-cast (or prefabricated) concrete or site cast (or in-situ) concrete. Each of which have their own advantages.

Pre-cast concrete is produced offsite (e.g. in a factory or manufacturing plant) by pouring concrete into pre-made moulds. As the curing conditions of concrete are often not ideal at a construction site, pre-cast concrete provides a higher quality of structure as the conditions of curing can be precisely controlled. Pre-cast elements (e.g. slabs) may be provided in various shapes and configurations and can use the best quality materials which may be difficult to source or transport to a construction site. However, transport of large pre-cast elements (e.g. pre-cast slabs, e.g. pre-cast beams) can be costly and difficult. Furthermore, once a structure has been assembled using a plurality of pre-cast elements (e.g. slabs or beams), it is often necessary to pour a further layer of concrete over the top of the assembled structure to provide continuity, further reinforcement and to ensure the required depth of concrete is

achieved which in turn ensures the stability of the structure. Also, pre-cast elements (e.g. slabs) often have a lesser benefit from the continuity since these are generally designed as single spans. Thus, the resulting component formed from the pre-cast element (e.g. slab) is typically thicker (i.e. contains a greater amount of concrete) than a comparative site-cast structure. However precast concrete often uses high proportions of cement replacement additives which will substantially reduce the CO2 emission such that provides a 'greener' concrete.

Pre-cast concrete therefore is advantageous over site cast concrete due to its faster construction time, reduced labour requirements and improved quality and consistency. However, there is a limit on the size of the pre-cast elements (e.g. slabs) that can be produced and thus pre-cast concrete elements (e.g. slabs) are less suitable for large complex structures.

On the other hand, site cast concrete involves pouring and curing the concrete on site to form the desired structure. This means that the building component may be poured to the desired depth initially and produces a monolithic structure which has improved resistance to bending, shear and seismic forces. Furthermore, site-cast concrete has greater customization than pre-cast concrete as the concrete can be poured into any shape or size, making it more suited to large, irregularly shaped and/or complex structures.

Both pre-casting and site-casting can be used with post-tensioning reinforcement method. However, post-tensioned concrete is typically site cast and pre-tensioning applied to some pre-cast elements (e.g. slabs) As such, typically, structures such as bridges may be formed using pre-tensioned pre-cast slabs/beams whereas structures, such as high-rise buildings or skyscrapers (which require superior strength, span large distances, and require design freedom) are built from site cast post-tensioned concrete.

Post-tensioned pre-cast concrete slabs/beams have been used in the construction of structures for a long period of time. For example, pre-cast elements with post-tensioning integrated therein is widely used in bridges such as segmental bridges where it is more cost effective and efficient to build each segment off-site and transport said segments to the site for installation. However, in such systems, tendons/strands span in a single direction (i.e. along the length of the bridge) and are designed as simply supported.

However, it has long been assumed in the art that post-tensioned pre-cast concrete elements (e.g. slabs) would be highly unsuitable for building construction since the existing

post-tensioned in-situ construction is easier and usually cheaper and can more readily address the complex support required for building stability. It is noted that there are examples of systems in the art which combine pre-cast elements with post-tensioning, however, such systems install post-tensioning on top of the pre-cast element rather than integrating pre-formed ducts within the pre-cast element itself. As such, these systems require a further layer of concrete to be cast on top of a pre-cast element (e.g. slab) which results in the full depth of the structural slab (i.e. part of the building element) being the sum of the depths of the pre-cast element and the subsequently poured concrete for the post-tensioning layer. This requirement to install ducting and then cast topping concrete on site for the post-tensioning layer results in little to no tangible gains in programme, labour reduction and carbon footprint and material reduction over a traditional post-tensioned slab. As such, there is a prejudice in the field against the combination of pre-cast element with post-tensioning, instead favouring traditional post-tensioning systems.

However, in recent years, the challenges facing the construction industry have changed and companies are now having to adapt to accommodate for ever reducing labour resources, to drive for “greener” process with reduced $CO_2$ emissions, to improve health and safety performances, and to reduce the time taken to complete a project. These challenges are not adequately addressed by existing solutions and thus there is a need in the art for a revolutionary system that can adapt to modern demands.

In particular, in the related art, structural rigidity and continuity between pre-cast slabs may be provided by providing reinforcement, in the form of rebar or similar, extending between pre-cast slabs. The present disclosure provides an alternative way of achieving sufficient structural rigidity and continuity between slabs while significantly reducing the need for reinforcement, such as rebar, in most applications.

The present inventors have thus developed an innovative method and system for constructing buildings (and components thereof) which aims to provide an optimised solution to the challenges facing the construction industry today. In particular, the present inventors have developed a modular concrete building component and method of assembly thereof that uses pre-cast concrete elements (e.g. slabs) that are manufactured offsite but assembled and post-tensioned on-site, thus resulting in an improved solution with reduced labour needs, reduced complexity, quicker programme and reduced carbon emissions by combining the benefits of post-tensioning and off-site manufacture.

**Summary**

The invention is defined in any independent claims.

Useful for understanding the disclosure, there is provided a method of assembling a modular concrete building component is provided. The modular concrete building component comprises two or more pre-cast concrete elements (e.g. slabs), wherein each pre-cast concrete element (e.g. slab) comprises:

a body defined by one or more sides, a first surface and a second surface;

a reinforcement cavity extending into the body through a first side of the one or more sides; and

a duct extending through the body towards the first side, wherein the duct is configured to receive a strand.

The method comprises:

positioning a first pre-cast concrete element (e.g. slab) adjacent to a second pre-cast concrete element (e.g. slab) such that:

the first side of the first pre-cast concrete element (e.g. slab) abuts the first side of the second pre-cast concrete slab;

the first surface of the first pre-cast concrete element (e.g. slab) and the first surface of the second pre-cast concrete element (e.g. slab) provide an extended first surface;

the second surface of the first pre-cast concrete element (e.g. slab) and the second surface of the second pre-cast concrete element (e.g. slab) provide an extended second surface;

the reinforcement cavity of the first pre-cast concrete element (e.g. slab) is aligned with the reinforcement cavity of the second pre-cast concrete element (e.g. slab) to provide an extended reinforcement cavity; and

the duct of the first pre-cast concrete element (e.g. slab) is positioned proximate to the duct of the second pre-cast concrete element (e.g. slab) to provide an extended duct;

inserting a reinforcement element into the extended reinforcement cavity;

threading a strand through the extended duct; and

tensioning the strand.

A building component may be provided by the method above.

A modular concrete building component may be provided (e.g. by the method above). The modular concrete building component comprises:

a first pre-cast concrete element (e.g. slab) and a second pre-cast concrete slab, wherein both the first pre-cast concrete element (e.g. slab) and the second pre-cast concrete element (e.g. slab) comprise:

a body defined by one or more sides, a first surface and a second surface;

a reinforcement cavity extending into the body through a first side of the one or more sides; and

a duct extending through the body towards the first side, wherein the duct is configured to receive a strand; and

wherein the first pre-cast concrete element (e.g. slab) and the second pre-cast concrete element (e.g. slab) are arranged adjacent to each other such that:

the first side of the first pre-cast concrete element (e.g. slab) abuts the first side of the second pre-cast concrete slab;

the first surface of the first pre-cast concrete element (e.g. slab) and the first surface of the second pre-cast concrete element (e.g. slab) provide an extended first surface;

the second surface of the first pre-cast concrete element (e.g. slab) and the second surface of the second pre-cast concrete element (e.g. slab) provide an extended second surface;

the reinforcement cavity of the first pre-cast concrete element (e.g. slab) is aligned with the reinforcement cavity of the second pre-cast concrete element (e.g. slab) to provide an extended reinforcement cavity, wherein the extended reinforcement cavity is configured to receive a reinforcement element; and

the duct of the first pre-cast concrete element (e.g. slab) is positioned proximate to the duct of the second pre-cast concrete element (e.g. slab) to provide an extended duct configured to receive a strand extending therethrough.

A building structure comprising the modular concrete component above may be provided.

There is described a continuous composite structural solution and method of assembling thereof which combines the benefits of off-site manufactured pre-cast concrete (e.g. the larger spans) and site cast post-tensioned concrete (e.g. thinness and superior strength). There is thus provided an improved modular concrete building component and method that can be universally used with reduced labour requirements, easier assembly and reduced material consumption and with cement replacements which, in turn, results in a reduced $CO_2$ footprint. The disclosure provides a number of advantages over other known systems as will be described below.

Importantly, all of these benefits have been provided without a reduction in the structural integrity or force resistance of the building component.

It will be appreciated that any suitable and/or desirable number and/or arrangement of the following optional features may be combined with other features described herein.

It will be appreciated that the method steps of any method disclosed herein may be rearranged in any suitable and/or desirable way. Optionally, the method steps may be performed sequentially in the order presented.

Within the meaning of the present disclosure a building component is part of a building which imparts structural integrity (e.g. part of the building's structure or foundation). It thus follows that a modular concrete building component is thus a building component that is formed by a plurality of modular units (e.g. the pre-cast concrete slabs) which are substantially formed from concrete (i.e. the main material or bulk material is concrete). It will be appreciated that the modular units (e.g. the pre-cast concrete slabs) are not necessarily 100% concrete (e.g. the ducts may be formed from metal ducting). However, the body of the pre-cast concrete elements (e.g. slabs) is preferably substantially made from (e.g. entirely) concrete (e.g. formed by pre-casting the element (e.g. slab) using a mould in a factory).

Optionally, the building component may provide a division within a building. For example, a wall may be considered to impart a division between two rooms on the same level, or the building and an outside environment. For example, a floor/ceiling may be considered to impart a division between two distinct levels (e.g. floors) of a building. Optionally, the modular concrete building component (e.g. assembled by the method disclosed herein) forms a floor and/or ceiling of a building. For example, the extended first surface forms the floor of a room in a building. For example, the extended second surfaces forms the ceiling of a room in a building. Optionally, the modular concrete building component (e.g. by the method disclosed herein, forms an internal (e.g. both sides of the wall are internal walls) or external wall (e.g. at least one side of the wall forms part of the building's exterior) of a building. For example, the first extended surface and the second extended surface are substantially perpendicular to the ground or a floor of the building.

Optionally, the modular concrete building component (e.g. assembled by the method disclosed herein) forms at least part of a low-rise building, a medium rise building, a high rise building or a skyscraper building. A low-rise building may be considered to be a building comprising from 1 to 4 floors, such as a residential dwelling. A medium rise building may be

considered to be a building comprising from 5 to 12 floors. A high-rise building may be considered to be a building comprising from 13 to 30 floors and/or being at least 20 m in height. A skyscraper may be considered to be a building comprising 31 or more floors (e.g. at least 35 floors, e.g. at least 40 floors) and/or having a height of at least 100 m, e.g. at least 120 m, e.g. at least 150 m.

Optionally, the method comprises positioning a first pre-cast concrete element (e.g. slab) flush against the second pre-cast concrete. Optionally, the modular concrete building component comprises the first pre-cast concrete element (e.g. slab) flush against the second pre-cast concrete slab. The first side of the (e.g. first, e.g. second) pre-cast concrete elements (e.g. slabs) may thus be configured to be complementary to each other such that the first and second pre-cast concrete elements (e.g. slabs) are substantially contiguous with each other.

It will be appreciated that when the first pre-cast concrete element (e.g. slab) is positioned adjacent to the second pre-cast concrete slab, (at least part of) the first side of the first pre-cast concrete element (e.g. slab) abuts (e.g. engages) with (at least part of) the first side of the second pre-cast concrete element (e.g. slab) such that a join or joint is provided between them. The reinforcement element may thus be considered to extend across the join to reinforce (or strengthen) the join between the first and second pre-cast concrete slab.

The pre-cast concrete elements (e.g. slabs) used herein may have any suitable and/or desirable shape. Furthermore, the (e.g. first and second, e.g. plurality of) pre-cast concrete elements (e.g. slabs) forming the modular concrete building component may have substantially the same shape or different shapes. Similarly, the (e.g. first and second, e.g. plurality of) pre-cast concrete elements (e.g. slabs) forming the modular concrete building component may be substantially the same size or different sizes. There is thus provided a flexible modular system that can be used to build building components of any desirable shape or size. It will be appreciated that the shape and/or size of the pre-cast concrete elements (e.g. slabs) is substantially defined by the body of the pre-cast concrete slabs.

As outlined above, each pre-cast concrete element (e.g. slab) (e.g. the first pre-cast concrete slab, e.g. the second pre-cast concrete slab) comprises a body defined by one or more sides, a first surface and a second surface. Optionally, the first surface and the second surface are in substantially parallel planes. For example, the first surface and the second surface are substantially parallel to each other. The one or more sides may thus be

considered to extend between the first surface and the second surface. Optionally, the one or more sides are substantially perpendicular to the first and/or second surfaces.

Optionally, the one or more sides (e.g. including the first side) of the (e.g. first, e.g. second, e.g. each) pre-cast concrete element (e.g. slab) may be planar or non-planar. Optionally, the first side of the pre-cast concrete element (e.g. slab) is substantially planar (e.g. to provide a flat surface which can sit flush against a first side of another (e.g. the second) pre-cast concrete slab). Optionally, all of the one or more sides of the (e.g. first, e.g. second, e.g. each) pre-cast concrete element (e.g. slab) form a first side surface which is configured to be positioned adjacent to a first side surface of another (e.g. the second) pre-cast concrete slab.

The body of each pre-cast concrete element (e.g. slab) may thus be considered to be defined by one or more first sides, a first surface and a second surface. Optionally, the (e.g. each, e.g. first, e.g. second) pre-cast concrete element (e.g. slab) comprises a plurality of first sides configured to be positioned adjacent to another (e.g. a plurality of second) pre-cast concrete slab(s). Optionally, each of the (e.g. plurality of) first sides comprise one or more reinforcement cavities extending into the body through said first side.

Optionally, the body of the (e.g. first, e.g. second, e.g. each) pre-cast concrete element (e.g. slab) is substantially a polyhedron in shape. It will be appreciated that the body of the (e.g. first, e.g. second, e.g. each) pre-cast concrete element (e.g. slab) is not a perfect polyhedron due to the presence of one or more reinforcement cavities (and other cavities, such as the coupling cavity discussed below) which essentially provide cut outs from the sides of the polyhedron body of the pre-cast concrete slabs. In other words, if the one or more reinforcement cavities (and any other cavities such as the coupling cavity) were absent, the body may have a polyhedron shape.

Optionally, (e.g. the body of) each pre-cast concrete element (e.g. slab) is selected to be one of a triangular prism, a rectangular cuboid (e.g. rectangular prism), a cube (e.g. a square prism), a pentagonal prism, a hexagonal prism, a heptagonal prism, an octagonal prism and so on. As such, optionally, the (e.g. each, e.g. first, e.g. second) pre-cast concrete element (e.g. slab) comprises three or more sides, e.g. three sides, e.g. four sides, e.g. five sides, e.g. six sides, e.g. seven sides, e.g. eight sides, e.g. nine sides, and so on. Optionally, the first surface and the second surface form the bases of the prism (e.g. have the polygon shape of the prism).

It will be appreciated that the first side of the first pre-cast concrete element (e.g. slab) may have a different length to the first side of the second pre-cast concrete slab. As such, the method may comprise positioning the first pre-cast concrete element (e.g. slab) adjacent to one or more second pre-cast concrete elements (e.g. slabs) such that the first side of the first pre-cast concrete element (e.g. slab) abuts the first side of one or more (e.g. two or more, e.g. a plurality of) second pre-cast concrete slabs.

As noted above, when the first pre-cast concrete element (e.g. slab) and the second pre-cast concrete element (e.g. slab) are positioned adjacent to each other, an extended first surface and an extended second surface are provided. Preferably, the extended first surface provides an exposed surface (e.g. a surface that is not hidden from view) in the final modular concrete building component. Preferably, the extended second surface provides an exposed surface (e.g. a surface that is not hidden from view) in the final modular concrete building component.

An exposed surface may be a surface that forms at least part of the final surface (e.g. floor surface, e.g. ceiling surface, e.g. wall surface) of the resulting building component (e.g. floor, e.g. ceiling, e.g. wall). An exposed surface may be covered with finishing materials, such as wallpaper, paint, tiles or carpet. An exposed surface may thus not be intended to exclude surfaces that are covered by finishing materials in the final building itself. However, a surface is not an exposed (e.g. concrete) surface if it is covered by a further layer of concrete (e.g. to increase the depth of the building component itself).

As such, the first surface(s) and the second surface(s) of the two or more pre-cast concrete elements (e.g. slabs) in the modular concrete building component (and the extended first and second surfaces provided therefrom) form the (e.g. exposed) surfaces of the building component (e.g. upon which users may walk). For example, the extended first surface may provide an interior or exterior wall surface, a floor surface or a ceiling surface. For example, the extended second surface may provide an interior or exterior wall surface.

Similarly, preferably, the method does not comprise pouring or covering the extended first surface or the extended second surface with a concrete layer. Thus, optionally, neither the extended first surface nor the extended second surface are covered by a (e.g. poured) concrete layer in the modular concrete building component. In other words, the extended first surface and the extended second surface are preferably exposed in the modular concrete building component.

The inventors have surprisingly been able to provide a solution where the depth of the first and second pre-cast concrete elements (e.g. slabs) is the sole determinator of the final depth of the building component (e.g. wall, e.g. floor, e.g. ceiling) made therefrom. This contrasts to other (e.g. pretensioned or post-tensioned) pre-cast systems that are covered by a layer of poured concrete after a plurality of pre-cast elements (e.g. slabs) have been assembled in order to increase the final building components depth and strength.

Optionally, the (e.g. first and second, e.g. plurality of) pre-cast concrete elements (e.g. slabs) may be cast to the final desired depth of the building component (e.g. walls, e.g. floor/ceiling). As such, when the first and second pre-cast concrete elements (e.g. slabs) are arranged adjacent to each other, at least two surfaces (i.e. the extended first surface and the extended second surface) are provided that form an exposed concrete surface of at least part of the final building component.

The present disclosure advantageously provides a thinner building component when compared to a comparative building component made by known pre-cast systems in the art. A thinner concrete building component uses less concrete material which in turn reduces the carbon emissions associated with the manufacture of the building component. Furthermore, by reducing the thickness of the building component, the disclosed arrangement allows additional floors to be built when compared to conventional techniques without increasing the overall height of the building. Thus, there are provided improved economic benefits for contractors. There is further provided a building component comparable to traditional post-tensioning methods (e.g. those where concrete is cast around ducts on site) but still take advantage of the improvements and advantages associated with pre-casting elements off-site.

Optionally, the first surface of one or more of the pre-cast concrete elements (e.g. slabs) is planar or non-planar. Optionally, the first surface of every pre-cast concrete element (e.g. slab) in the modular concrete building component is planar such that the extended first surface is planar. Optionally, the first surface of one or more of the pre-cast concrete elements (e.g. slabs) in the modular concrete building component is planar and the first surface of one or more of the pre-cast concrete elements (e.g. slabs) in the modular concrete building component is non-planar.

Optionally, the extended first surface is planar or non-planar. Optionally, the first surface of one or more (e.g. all) of the pre-cast concrete elements (e.g. slabs) in the modular concrete

building component is planar and comprises a pattern of surface features (e.g. to create an interesting or visually appealing topography or tactile surface).

Optionally, the extended first surface is planar and comprises a pattern of surface features (e.g. to create an interesting or visually appealing topography or tactile surface). For example, when the (e.g. extended) first surface provides part of a wall or ceiling surface, it may be desirable for the (e.g. extended) first surface to include a plurality of surface features or a (e.g. visually appealing) surface topography. Optionally, when the (e.g. extended) first surface is part or all of a floor surface, the (e.g. extended) first surface is planar to allow users to walk thereon comfortably. The pattern of surface features on the extended first surface may be formed by virtue of some (or all) of the first surface of the pre-cast concrete elements (e.g. slabs) themselves comprising surface features.

Optionally, the second surface of one or more of the pre-cast concrete elements (e.g. slabs) is planar or non-planar. Optionally, the second surface of every pre-cast concrete element (e.g. slab) in the modular concrete building component is planar such that the extended second surface is planar. Optionally, the second surface of one or more of the pre-cast concrete elements (e.g. slabs) in the modular concrete building component is planar and the second surface of one or more of the pre-cast concrete elements (e.g. slabs) in the modular concrete building component is non-planar.

Optionally, the extended second surface is planar or non-planar. Optionally, the second surface of one or more (e.g. all) of the pre-cast concrete elements (e.g. slabs) in the modular concrete building component is planar and comprises a pattern of surface features (e.g. to create an interesting or visually appealing topography or tactile surface).

Optionally, the extended second surface is planar and comprises a pattern of surface features (e.g. to create an interesting or visually appealing topography or tactile surface). For example, when the (e.g. extended) second surface provides part of a wall or ceiling surface, it may be desirable for the (e.g. extended) second surface to include a plurality of surface features or a (e.g. visually appealing) surface topography. Optionally, when the (e.g. extended) second surface is part or all of a floor surface, the (e.g. extended) second surface is planar to allow users to walk thereon comfortably. The pattern of surface features on the extended second surface may be formed by virtue of some (or all) of the second surface of the pre-cast concrete elements (e.g. slabs) themselves comprising surface features.

Optionally, the first surface of the first pre-cast concrete element (e.g. slab) is continuous with the first surface of the second pre-cast concrete element (e.g. slab) when the two pre-cast concrete elements (e.g. slabs) are positioned adjacent to each other. Optionally, the second surface of the first pre-cast concrete element (e.g. slab) is continuous with the second surface of the second pre-cast concrete element (e.g. slab) when the two pre-cast concrete elements (e.g. slabs) are positioned adjacent to each other.

Optionally, each pre-cast concrete element (e.g. slab) has the same depth, wherein the depth is defined as the distance between the (e.g. extended) first surface and the (e.g. extended) second surface (e.g. a dimension of the one or more (e.g. first) sides). As such, when the first pre-cast concrete element (e.g. slab) is positioned adjacent to the second pre-cast concrete slab, the first side of the first precast concrete element (e.g. slab) and the first side of the second pre-cast concrete element (e.g. slab) are preferably hidden (e.g. obscured from view). In other words, the second pre-cast concrete element (e.g. slab) optionally obscures the first side of the first pre-cast concrete element (e.g. slab) from view, and vice versa.

Optionally, the first surface of the first pre-cast concrete element (e.g. slab) is discontinuous with the first surface of the second pre-cast concrete element (e.g. slab) when the two pre-cast concrete elements (e.g. slabs) are positioned adjacent to each other. Optionally, the second surface of the first pre-cast concrete element (e.g. slab) is discontinuous with the second surface of the second pre-cast concrete element (e.g. slab) when the two pre-cast concrete elements (e.g. slabs) are positioned adjacent to each other.

Optionally, the first pre-cast concrete element (e.g. slab) and the second pre-cast concrete element (e.g. slab) may have different depths. In such arrangements, positioning the second pre-cast concrete element (e.g. slab) adjacent to the second pre-cast concrete element (e.g. slab) will result in at least part of the first side of one of the pre-cast concrete elements (e.g. slabs) being exposed. This can be used to provide an extended first surface having a (e.g. visually appealing) relief pattern created by the differences in depths of the slabs.

The reinforcement cavity of each pre-cast concrete element (e.g. slab) extends into the body of the pre-cast concrete element (e.g. slab) through a first side of the one or more sides. In other words, the reinforcement cavity optionally extends through the first side and into (but not all the way through) the body. The reinforcement cavities of each pre-cast concrete element (e.g. slab) are used to reinforce the join between two (e.g. the first and the second) pre-cast concrete elements (e.g. slabs) by aligning two reinforcement cavities of two different

pre-cast concrete elements (e.g. slabs) to provide an extended reinforcement cavity and inserting a reinforcement element therein. Each pre-cast concrete element (e.g. slab) may therefore comprise at least one reinforcement cavity.

Optionally, each pre-cast concrete element (e.g. slab) of the two or more pre-cast concrete elements (e.g. slabs) may each comprise a plurality (e.g. two or more) reinforcement cavities. For example, each pre-cast concrete element (e.g. slab) may comprise a plurality (e.g. two or more) reinforcement cavities extending through the first side of the one or more sides. In other words, the first side of the first pre-cast concrete element (e.g. slab) and the first side of the second pre-cast concrete element (e.g. slab) may each comprise a plurality of reinforcement cavities such that, when the first pre-cast element (e.g. slab) is adjacent to the second pre-cast slab, a plurality of extended reinforcement cavities is provided. As such, when the first pre-cast concrete element (e.g. slab) is positioned next to the second pre-cast concrete slab, two or more of reinforcement cavities on the first pre-cast concrete are aligned with two or more of the reinforcement cavities on the second pre-cast concrete element (e.g. slab) such that a plurality of extended reinforcement cavities (each configured to receive a reinforcement element) are provided.

Optionally, when a (e.g. the first, e.g. the second) pre-cast concrete element (e.g. slab) comprises two or more sides, two or more (e.g. all) of the two or more sides may comprise a (e.g. one or more, e.g. two or more, e.g. a plurality of) reinforcement cavity. As such, the (e.g. first, e.g. second) pre-cast concrete element (e.g. slab) may be joined (and the join reinforced) to another pre-cast concrete element (e.g. slab) on sides further to the first side.

Each reinforcement cavity may have any suitable and/or desirable shape and configuration. Furthermore, when a pre-cast concrete element (e.g. slab) comprises a plurality of reinforcement cavities, each reinforcement cavity may be substantially identical in shape and/or configuration to another reinforcement cavity or may be different in shape and/or configuration.

Optionally, a reinforcement cavity extends through the (e.g. first, e.g. one of the one or more) side(s) at a substantially perpendicular angle to the plane of the side it extends through. Optionally, the (e.g. each) extended reinforcement cavity extends substantially perpendicularly to the join between the (e.g. first and second) pre-cast concrete elements (e.g. slabs) positioned adjacent to each other.

Optionally, the (e.g. each) reinforcement cavity is substantially linear. Optionally, the (e.g. each) extended reinforcement cavity is substantially linear.

Optionally, the (e.g. each) reinforcement cavity is a groove (or channel) formed through the first surface. In other words, the (e.g. each) reinforcement cavity optionally extends into (but not all the way through) the body through both the first side and the first surface. For example, the (e.g. each) reinforcement cavity is a groove or channel that provides an opening at the first side. Optionally, the (e.g. each) extended reinforcement cavity is a groove (or channel) formed through the extended first surface. As such, the (e.g. extended) reinforcement cavity may be accessible through the (e.g. extended) first surface such that the reinforcement element may be easily inserted into the extended reinforcement cavity after the (e.g. first and second) pre-cast concrete elements (e.g. slabs) have been positioned adjacent to each other. The method may thus comprise inserting the reinforcement element into the extended reinforcement cavity through the plane of the extended first surface. This improves the speed at which the modular concrete building system can be constructed as the pre-cast concrete elements (e.g. slabs) may be easily aligned from visual inspection, thus reducing the complexity of the construction without sacrificing the strength of the resulting structure.

Optionally, the groove (or channel) has any suitable and/or desirable shape. The shape of the groove (or channel) may be defined by a first cross-sectional shape and a second cross-sectional shape, wherein the first cross-sectional shape is in the plane of the first surface and the second cross-sectional shape is in the plane of the second surface. The first and second cross-sectional shapes may be regular polygons, irregular polygons, or any other shape. Optionally, the first cross-sectional shape may be a rectangle. Optionally, the second cross-sectional shape may be a square, a rectangle, a semi-circle, a trapezoid, a u-shape, or any other suitable and/or desirable shape. Optionally, the groove (or channel) may be a shape formed by an amalgamation of two or more polygons. For example, the groove (or channel) may have a shape comprising a rectangular portion with a circular portion thus forming a groove having a straight portion with a bulbous (bottom) portion. The groove (or channel) may be suitably sized and shape to receive (at least part of) the reinforcement element therein.

Optionally, the (e.g. each) reinforcement cavity may be a blind bore extending through the (e.g. first) side. Optionally, the blind bore has any suitable and/or desirable cross-sectional shape such as a circle, square or rectangle. Optionally, the (e.g. each) reinforcement cavity (e.g. blind bore) is not visible or accessible through the extended first surface after the (e.g.

first and second) pre-cast concrete elements (e.g. slabs) have been positioned adjacent to each other. In such examples, the method may further comprise inserting a reinforcement element into the reinforcement cavity of the first pre-cast concrete slab; positioning the second pre-cast concrete element (e.g. slab) next to the first pre-cast concrete element (e.g. slab) such that a reinforcement cavity on the second pre-cast concrete element (e.g. slab) is aligned with the reinforcement element (and thus the reinforcement cavity of the first pre-cast concrete slab); and inserting (e.g. sliding) the reinforcement element into the reinforcement cavity of the first pre-cast concrete element (e.g. slab) (e.g. by moving the first pre-cast concrete element (e.g. slab) towards the second pre-cast concrete slab, e.g. by moving the second pre-cast concrete element (e.g. slab) towards the firs pre-cast concrete slab, e.g. by moving the two pre-cast concrete elements (e.g. slabs) together) until the first side of the first pre-cast concrete element (e.g. slab) engages with the first side of the second pre-cast concrete slab.

Optionally, the (e.g. each) reinforcement cavity may be provided at any suitable and/or desirable position along the (e.g. first) side it extends through. In other words, the bottom of the reinforcement cavities may be provided at any suitable and/or desirable depth relative to the (e.g. extended) first surface. Optionally, the depth is sufficient to allow the reinforcement element to be entirely received within the (e.g. extended) reinforcement cavity such that the reinforcement element does not extend beyond the extended first surface. Optionally, the depth of the reinforcement cavity is greater than or equal to the depth of the reinforcement element.

Optionally, the first side of the pre-cast concrete element (e.g. slab) may comprise a plurality of (e.g. two or more) reinforcement cavities extending therethrough. Optionally, the plurality of reinforcement cavities are provided along the first side at substantially the same depth relative to the first surface. In other words, the plurality of reinforcement cavities may be provided along the first side in a row (e.g. linear line) substantially parallel to the first surface.

Optionally, the plurality of (e.g. extended) reinforcement cavities are provided at two or more depths relative to the first surface. Thus, optionally, the plurality of (e.g. extended) reinforcement cavities are configured to receive (e.g. at least part of) two or more reinforcement elements (optionally, one reinforcement element per extended reinforcement cavity) at two or more depths relative to the (e.g. extended) first surface. As such, the integrity of the reinforcement of the join between the first pre-cast concrete element (e.g. slab) and the second pre-cast concrete element (e.g. slab) is improved.

Optionally, each pre-cast concrete element (e.g. slab) may comprise a plurality of sides, wherein two or more of the plurality of sides comprises one or more reinforcement cavities. Optionally, the reinforcement cavities may be provided at the same depths along all of the plurality of sides. Optionally, the reinforcement cavities on different sides may be provided at different depths relative to the first surface.

Optionally, each of the reinforcement cavities on the first pre-cast concrete element (e.g. slab) aligns with a reinforcement cavity on the second pre-cast concrete slab, thus forming a pair of reinforcement cavities (which together provide the extended reinforcement cavity). Optionally, the shape and configuration of the pair of reinforcement cavities are identical such that each reinforcement cavity in the pair may be considered to be a mirror image of the other reinforcement cavity in the pair. Optionally, the shape and configuration of the pair of reinforcement cavities may be different. For example, the two reinforcement cavities may have different lengths (e.g. extend into the bodies of their respective pre-cast concrete elements (e.g. slabs) to different extents. This may be necessary if one of the pre-cast concrete elements (e.g. slabs) is larger due to long spans than the other and thus longer connection reinforcement across the join is necessary.

The method comprises inserting a reinforcement element into the extended reinforcement cavity, wherein the reinforcement element extends into both the first pre-cast concrete element (e.g. slab) and the second pre-cast concrete slab. The extended reinforcement cavity of the modular concrete building component is thus configured to receive a reinforcement element. Optionally, the (e.g. each) extended reinforcement cavity is configured to receive one reinforcement element. Optionally, each reinforcement cavity is configured to receive two or more reinforcement elements.

Optionally, the method comprises inserting the reinforcement element into extended reinforcement cavity such that reinforcement element extends into both the first pre-cast concrete element (e.g. slab) and the second pre-cast concrete slab. Optionally, the modular concrete building component further comprises a (e.g. one or more) reinforcement element(s) within the (e.g. one or more) reinforcement cavity/cavities, wherein the reinforcement element extends into both the first pre-cast concrete element (e.g. slab) and the second pre-cast concrete slab. In other words, the reinforcement element optionally extends across the join formed by the abutting first surfaces of the first pre-cast concrete element (e.g. slab) and the second pre-cast concrete slab.

The reinforcement element may take any suitable and/or desirable form. For example, the reinforcement element may be a rod or bar. Optionally, the reinforcement element may be wire rope or (e.g. metal, e.g. steel) cables. Optionally, the reinforcement element is made from a metal, a metallic-based material or composite material. Optionally, the reinforcement element is a metal (e.g. steel) rod or bar.

Optionally, the method further comprises filing the extended reinforcement cavity with a grouting material to secure the reinforcement element within the extended reinforcement cavity. The modular concrete building component that may further comprise a grouting material within the extended reinforcement cavity. Optionally, the grouting material is a settable grouting material that cures or hardens. Optionally, the (e.g. settable) grouting material encloses (e.g. encases) the reinforcement element within the extended reinforcement cavity and is configured to fix the reinforcement element within the extended reinforcement cavity.

The grouting material may have any suitable and/or desirable composition. Optionally the grouting material comprises sand, cement and water and/or additives. Optionally, the grouting material may comprise or consist of a resin or mixture of resins.

Optionally, the extended reinforcement cavity is filled with the (e.g. settable) grouting material until the (e.g. settable) grouting material is substantially level with the extended first surface. Optionally, the extended reinforcement cavity is filled with the settable grouting material whilst the grouting material is in a fluid form. Optionally, the method comprises levelling the grouting material (e.g. using a levelling trowel, e.g. whilst the grouting material is still fluid) such that the top surface of the grouting material (e.g. when the grouting material is set) is substantially level to (and continuous with) the extended first surface. Optionally, the modular concrete building component comprises grouting material that fills the reinforcement cavity (e.g. with the reinforcement element therein) such that the top surface provided by the grouting material is substantially level with the extended first surface (e.g. when the grouting material is set).

Each pre-cast concrete element (e.g. slab) (e.g. the first pre-cast concrete slab, e.g. the second pre-cast concrete slab) comprises a duct extending through the body towards the first side. For example, when the pre-cast concrete element (e.g. slab) has a plurality of sides, the duct extends between the first side and another side of the plurality of sides. For example, when the pre-cast concrete element (e.g. slab) has one side (e.g. the pre-cast concrete element (e.g. slab) is formed from a continuous (e.g. curved) boundary or side)

comprising the first side as a portion of the said one side, the duct extends between the first side portion towards another side portion.

Optionally, the first duct extends across the (e.g. first, e.g. second, e.g. each) pre-cast concrete element (e.g. slab) from the first side surface to an opposing side surface. Optionally, the opposing side surface is substantially parallel with the first surface. Optionally, the duct of the first pre-cast concrete element (e.g. slab) the duct of the second pre-cast concrete element (e.g. slab) each extend from their respective first sides to another (e.g. parallel) side.

The method comprises positioning a first pre-cast concrete element (e.g. slab) adjacent to a second pre-cast concrete element (e.g. slab) such that the duct of the first pre-cast concrete element (e.g. slab) is positioned proximate to the duct of the second pre-cast concrete slab. This allows threading (e.g. insertion) of a (e.g. common) strand through both of the ducts. Similarly, the modular concrete building component comprises the first pre-cast concrete element (e.g. slab) adjacent to the second pre-cast concrete element (e.g. slab) such that the duct of the first pre-cast concrete element (e.g. slab) is positioned proximate to the duct of the second pre-cast concrete element (e.g. slab) and the two ducts are configured to receive a common strand extending therethrough.

As such, when the first pre-cast concrete element (e.g. slab) is positioned adjacent to the second pre-cast concrete slab, and the ducts of the first pre-cast concrete element (e.g. slab) and the second pre-cast concrete element (e.g. slab) are positioned proximate to each other, an extended duct across the first pre-cast concrete element (e.g. slab) and the second pre-cast concrete element (e.g. slab) is provided through which a common strand may be threaded (e.g. for post-tensioning of the pre-cast concrete slabs). It will be appreciated that there is no limit as to how long an extended duct may be. Indeed, in a modular concrete component comprising a plurality of (e.g. first and second) pre-cast concrete slabs, an extended duct may extend across the length or width of the component across a plurality of pre-cast concrete slabs.

The duct provides an opening at two or more sides (or side portions) of the pre-cast concrete element (e.g. slab) through which a strand may be threaded. The duct is thus configured to receive a strand threaded therethrough and may be considered to act as a guide or pathway for the strand through a plurality of pre-cast concrete slabs.

Optionally, the duct is enclosed within the body of the (e.g. first, e.g. second, e.g. every) pre-cast concrete slab. As such, the duct may not be visible when viewing the pre-cast concrete element (e.g. slab) from above the first surface and/or below the second surface.

Optionally, the duct terminates at the plane defined by the first surface (e.g. and the plane defined by the other surface between which the duct extends). Optionally, the duct does not extend beyond the boundary defined by the one or more sides and the first and second surface of the pre-cast concrete slab.

Optionally, the duct may extend into a coupling cavity located at the first side of the pre-cast concrete slab. Optionally, both sides (or side portions) between which the duct extends may comprise a coupling cavity into which the ends of the duct extend. As such, although the duct may not extend beyond the planes of the sides (between which it extends), the duct may be visible when viewed from above the first surface or below the second surface of the pre-cast concrete element (e.g. slab) by virtue of the fact that the duct extends into the coupling cavities. The coupling cavities are described in more detail below.

Optionally, the duct of the first pre-cast concrete element (e.g. slab) and the duct of the second pre-cast concrete element (e.g. slab) extend along substantially the same axis. Optionally, the duct of the first pre-cast concrete element (e.g. slab) and the duct of the second pre-cast concrete element (e.g. slab) provide an extended duct that (e.g. when projected onto the plane of the first surface) extends (e.g. linearly) along the plane perpendicular to the (e.g. extended) first surface.

Optionally, the (e.g. extended) duct may extend curvilinearly across the (e.g. first, e.g. second, e.g. first and second) pre-cast concrete slab(s). Optionally, the extended duct (e.g. formed by the first and the second duct, e.g. formed by a plurality of ducts in a series of adjacent pre-cast concrete slabs) provides a curvilinear path across the (e.g. first and second, e.g. plurality of) pre-cast concrete slabs. Optionally, the curvilinear path lies in the plane perpendicular to the (e.g. extended). As such, the duct may be at a varying depth (e.g. distance from either the first surface or the second surface) within the body of the pre-cast concrete slab. Preferably, the curvature of the curvilinear path lies in the same plane, e.g. the plane parallel to the first surface. As such, the duct extends substantially linearly when projected onto a plane parallel to the first surface but may bend and/or curve in the plane perpendicular to the first surface. The curvature of the curvilinear path may be implemented such that, after tensioning, downward forces are exerted on portions of the element (e.g.

slab) where pillars may be, and upward forces are exerted on portions of the element (e.g. slab) which are unsupported by pillars.

Optionally, each duct is fixedly enclosed within the (e.g. first, e.g. second) pre-cast concrete slab(s). In other words, the ducts are not removable from the body of the pre-cast concrete slab. Indeed, the pre-cast concrete element (e.g. slab) may be formed by casting the pre-cast concrete element (e.g. slab) around the duct(s) such that the concrete hardens around the ducts, holding them in position when the concrete is set.

The duct may take any suitable and/or desirable form and/or be made from any suitable or desirable material. Optionally, the duct may have concrete walls. For example, when manufacturing the pre-cast concrete slab, a duct former may be installed within a mould such that, when the concrete is poured into the mould and allowed to harden, it hardens around the duct former. The duct former may then be removed by any suitable and/or desirable means leaving a duct within the body of the pre-cast concrete slab. For example, the duct former could be physically removed (e.g. by pulling or breaking the duct former). For example, the duct former could be chemically removed (e.g. dissolved, disintegrated or degraded in a chemical solvent).

Optionally, the duct may be a metal duct. For example, the duct may be a metal tubing or ducting around which the concrete is cast within a mould. Any suitable and/or desirable metal may be used for the duct. For example, the metal duct may be made from aluminium.

Optionally, the first pre-cast concrete element (e.g. slab) and the second pre-cast concrete element (e.g. slab) each comprise a plurality of ducts extending through the body's thereof, wherein each duct of the plurality of ducts may be configured to be parallel or perpendicular to another duct of the plurality of ducts. It will be appreciated that each of the plurality of ducts may independently comprise characteristics as described above. Thus, there is no requirement for all the ducts within a singled pre-cast concrete element (e.g. slab) to have the same characteristics or configurations.

Optionally, the (e.g. first, e.g. second, e.g. each) pre-cast concrete element (e.g. slab) comprises a plurality of ducts. Optionally, each duct of the plurality of ducts may be provided at one or more depths with respect to the distance from the first surface. Optionally, the plurality of ducts provides a plurality of openings (e.g. through which a plurality of strands may be threaded) at the first side at one or more depths with respect to the first surface. This

allows the (e.g. first, e.g. second, e.g. each) pre-cast concrete element (e.g. slab) to be reinforced at one or more depths.

Optionally, the pre-cast concrete element (e.g. slab) comprises a plurality of ducts, wherein the plurality of ducts may be provided at substantially the same depth with respect to the distance from the first surface. Optionally, the plurality of ducts provides a plurality of openings (e.g. through which a plurality of strands may be threaded) at the first side at substantially the same depth with respect to the first surface.

Optionally, the plurality of ducts may be parallel to each other. For example, the plurality of ducts may extend between the same two sides (e.g. the first side and another side) in parallel. Optionally, the plurality of ducts may be perpendicular to each other. Optionally, the plurality of ducts may be substantially equidistant from each other and/or substantially evenly distributed across the pre-cast concrete slab.

Optionally, the modular concrete building component further comprises a strand extending through both the duct of the first pre-cast concrete element (e.g. slab) and the duct of the second pre-cast concrete slab. In other words, the modular concrete building component further comprises a strand extending through the extended duct formed by the duct of the first pre-cast concrete element (e.g. slab) and the duct of the second pre-cast concrete slab. As such, the same strand extends through both the ducts of the first pre-cast concrete element (e.g. slab) and the second pre-cast concrete element (e.g. slab) (and any further pre-cast concrete elements (e.g. slabs) aligned therewith). The strand may then be tensioned within the ducts.

Optionally, the one or more ducts of the first pre-cast concrete element (e.g. slab) extends into a coupling cavity located at the first side of the first pre-cast concrete slab. It will be appreciated that the coupling cavity is distinct and separate from the reinforcement cavity.

In such examples, the method may further comprise positioning the first pre-cast concrete element (e.g. slab) adjacent to the second pre-cast concrete element (e.g. slab) such that the duct of the second pre-cast concrete element (e.g. slab) extends toward the coupling cavity of the first pre-cast concrete slab. Similarly, the first pre-cast concrete element (e.g. slab) and the second pre-cast concrete element (e.g. slab) are arranged adjacent to each other such that the duct of the second pre-cast concrete element (e.g. slab) extends towards (e.g. is aligned with) the coupling cavity of the first pre-cast concrete element (e.g. slab) in the modular concrete building component. The coupling cavity may thus act to provide an

element of tolerance for the alignment between the ducts of the first pre-cast concrete element (e.g. slab) and the second pre-cast concrete slab. This thus improves the tolerance for the alignment of the two ducts which, in turn, reduces the precision required during casting of the pre-cast concrete slabs.

In such examples, the duct of the second pre-cast concrete element (e.g. slab) may itself also extend into a coupling cavity located at the first side of the second pre-cast concrete element (e.g. slab) such that the coupling cavity of the first pre-cast concrete element (e.g. slab) is aligned with the coupling cavity of the second pre-cast concrete slab, which in turn provides the ducts of the first and second pre-cast concrete elements (e.g. slabs) in proximity to each other. Alternatively, the duct of the second pre-cast concrete element (e.g. slab) may not comprise a coupling cavity. For example, the duct of the second pre-cast concrete element (e.g. slab) may not extend into a coupling cavity but simply provides an opening at a fixed position on the first side.

Optionally, the method comprises coupling the duct of the first pre-cast concrete element (e.g. slab) to the duct of the second pre-cast concrete element (e.g. slab) using a coupling element. Similarly, the modular concrete building component further comprises a coupling element configured to couple the duct of the first pre-cast concrete element (e.g. slab) to the duct of the second pre-cast concrete slab. The coupling element may couple or join the ducts together by being attached to both the duct of the first pre-cast concrete element (e.g. slab) and the duct of the second pre-cast concrete slab.

Optionally, when only one of the ducts being joined extends into a coupling cavity (e.g. and the other duct terminates at a solid surface (e.g. wall) of the first side), the coupling element is disposed wholly within the coupling cavity of the first pre-cast concrete slab. Optionally, when both the ducts of the first pre-cast concrete element (e.g. slab) and the second pre-cast concrete element (e.g. slab) extend into a coupling cavity, the coupling element may extend across the join between the first pre-cast concrete element (e.g. slab) and the second pre-cast concrete slab. Optionally, the coupling element does not extend beyond the plane of the extended first surface. In other words, the coupling element may be wholly received within the extended coupling cavity.

Optionally, the duct of each (e.g. the first, e.g. the second) pre-cast concrete element (e.g. slab) extends into a coupling cavity located at the first side of the pre-cast concrete slab. As such, the method further comprises positioning the first pre-cast concrete element (e.g. slab) adjacent to the second pre-cast concrete element (e.g. slab) such that a coupling cavity of

the first pre-cast concrete element (e.g. slab) is aligned with a coupling cavity of the second pre-cast concrete element (e.g. slab) to provide an extended coupling cavity into which the duct of the first pre-cast concrete element (e.g. slab) and the duct of the second pre-cast concrete element (e.g. slab) extends. Similarly, the first pre-cast concrete element (e.g. slab) and the second pre-cast concrete element (e.g. slab) are arranged adjacent to each other such that the coupling cavity of the first pre-cast concrete element (e.g. slab) is aligned with the coupling cavity of the second pre-cast concrete element (e.g. slab) to provide an extended coupling cavity in the modular concrete building component, wherein both the duct of the first pre-cast concrete element (e.g. slab) and duct of the second pre-cast concrete element (e.g. slab) extend into the extended coupling cavity.

Optionally, the extended coupling cavity of the first pre-cast concrete element (e.g. slab) has a substantially rectangular cross-sectional shape in the plane of the (e.g. first) side. Optionally, the extended coupling cavity has any suitable and/or desirable shape. The shape of the extended coupling cavity may be defined by a first cross-sectional shape and a second cross-sectional shape, wherein the first cross-sectional shape is in the plane of the first surface and the second cross-sectional shape is in the plane of the second surface. The first and second cross-sectional shapes may be regular polygons, irregular polygons, or any other shape. Optionally, the first cross-sectional shape may be a rectangle. Optionally, the second cross-sectional shape may be a square or a rectangle. The extended coupling cavity may be suitably sized and shape to receive the ducts and optionally a coupling element.

Optionally, the (e.g. extended) coupling cavity may be accessible through the (e.g. extended) first surface such that the coupling element may be easily inserted into the coupling cavity to couple the two ducts together after the (e.g. first and second) pre-cast concrete elements (e.g. slabs) have been positioned adjacent to each other. The method may thus comprise inserting the coupling element into the extended coupling cavity through the plane of the extended first surface and/or coupling the duct of the first pre-cast concrete element (e.g. slab) to the duct of the second pre-cast concrete element (e.g. slab) at a position within the extended coupling cavity using a coupling element to provide a coupled extended duct through which the strand is threaded. This improves the speed at which the modular concrete building system can be constructed as the pre-cast concrete elements (e.g. slabs) may be easily aligned from visual inspection, thus reducing the complexity of the construction without sacrificing the strength of the resulting structure.

Optionally, the coupling cavity is configured such that only a short portion of the end of the duct extends therein. For example, less than 20 cm (e.g. less than 18 cm, e.g. less than 17

cm, e.g. less than 15 cm, e.g. less than 12 cm, e.g. less than 10 cm, e.g. less than 8 cm, e.g. less than 5 cm, e.g. less than 4 cm, e.g. less than 3 cm, e.g. less than 2 cm) of the end of the duct extends into the coupling cavity, with the rest of the duct enclosed within the body of pre-cast concrete slab. However, to ensure that there is a long enough length of duct for the coupling element to attach to, optionally, more than 1 cm (e.g. more than 2 cm, e.g. more than 3 cm, e.g. more than 4 cm, e.g. more than 5 cm, e.g. more than 8 cm, e.g. more than 10 cm) of the end of the duct extends into the coupling cavity.

Optionally, the first side surface comprises one or more coupling cavities, wherein the number of coupling cavities equals the number of ducts extending towards the first side. Optionally, each duct extends into a different coupling cavity.

Optionally, the method further comprises filing the extended coupling cavity with a grouting material to secure the duct of the first pre-cast concrete element (e.g. slab) and the duct of the second pre-cast concrete element (e.g. slab) (e.g. the extended duct) within the extended reinforcement cavity. Similarly, the modular concrete building component optionally further comprises a grouting material within the extended coupling cavity, wherein the grouting material encloses the duct of the first pre-cast concrete element (e.g. slab) and the duct of the second pre-cast concrete element (e.g. slab) (e.g. the extended duct) and is configured to fix the duct of the first pre-cast concrete element (e.g. slab) and the duct of the second pre-cast concrete element (e.g. slab) within the extended coupling cavity.

Optionally, the duct of the first pre-cast concrete element (e.g. slab) and the duct of the second pre-cast concrete element (e.g. slab) are coupled by a coupling element to provide a coupled extended duct, and the extended coupling cavity is filled with a (e.g. settable) grouting material which encloses and fixes the extended duct of the first pre-cast concrete element (e.g. slab) and duct of the second pre-cast concrete element (e.g. slab) within the extended coupling cavity

Optionally, the grouting material is a settable grouting material that cures or hardens. Optionally, the (e.g. settable) grouting material encloses (e.g. encases) the reinforcement element within the extended reinforcement cavity and is configured to fix the reinforcement element within the extended reinforcement cavity.

The grouting material may have any suitable and/or desirable composition. Optionally the grouting material comprises sand, cement and water and/or additives. Optionally, the grouting material may comprise or consist of a resin or mixture of resins.

Optionally, the grouting material fills the coupling cavity such that a top surface provided by the grouting material is substantially level with the (e.g. extended) first surface of the (e.g. first, e.g. second, e.g. first and second) pre-cast concrete slab. As such, the method optionally comprises filling the extended coupling cavity with grouting material until the grouting material is substantially level with the extended first surface.

The coupling element may be any suitable and/or desirable element, fixture or fitting. Optionally, the coupling element is configured to prevent grouting material from seeping into the duct. This helps to prevent the duct pathway intended for the strand from being blocked or impeded unintentionally. Optionally, the coupling element is configured to receive an end of the duct of the first pre-cast concrete element (e.g. slab) and an end of the duct of the second pre-cast concrete slab. For example, the coupling element may be a length of ducting. Optionally, the end of each duct received within the coupling element is at least 1 cm (e.g. at least 1.5 cm, e.g. at least 2 cm, e.g. at least 30cm) long.

Optionally, the coupling element comprises a length of ducting that is configured to wrap around part of (e.g. the end of) the duct of the first pre-cast concrete element (e.g. slab) and part of (e.g. the end of) the duct of the second pre-cast concrete slab. Optionally, the end of each duct that engages with the coupling element is at least 1 cm (e.g. at least 1.5 cm, e.g. at least 2 cm, e.g. at least 30cm) long.

Optionally, the coupling element comprises one or more layers of tape. For example, the one or more layers of tape may be configured to seal the coupling between the ducts. Optionally, the coupling element comprises tape (e.g. helically) wound around (e.g. on top of) the first duct and the second duct. Optionally, the coupling element comprises a length of ducting inside which both ends of the duct are received, and one or more layers of tape (e.g. helically) wound on top of the length of ducting. Optionally, the one or more layers of tape extend past the length of ducting such that tape engages with a portion of each duct and the length of ducting.

The method comprises installation (e.g. after the inserting step) a strand through both the duct of the first pre-cast concrete element (e.g. slab) and the duct of the second pre-cast concrete slab. Thus, optionally, the modular concrete building component comprises a strand received within the ducts of the (e.g. first and second) pre-cast concrete slabs. The duct of the first pre-cast concrete element (e.g. slab) and the duct second pre-cast concrete element (e.g. slab) are positioned proximate to each other such that the duct of the first pre-

cast concrete element (e.g. slab) and the duct of the second pre-cast concrete element (e.g. slab) are configured to receive the same strand.

The strand received in the duct should be configured to withstand tensioning forces as required by the design. Optionally, the strand is formed from a plurality of steel wires or elements. Optionally, the strand is a steel strand. For example, the strand may comprise a plurality of ahigh tensile steel wires bundled together. It will be appreciated that any known or conventional strand used for post-tensioning in the art may be used.

The modular concrete building component comprises two (e.g. a first and a second) or more pre-cast concrete slabs. Optionally, the modular concrete building component comprises a plurality of first pre-cast concrete elements (e.g. slabs) and a plurality of second pre-cast concrete slabs. Optionally, the modular concrete building component comprises a plurality of first pre-cast concrete elements (e.g. slabs) and a plurality of second pre-cast concrete elements (e.g. slabs) arranged to provide a row of pre-cast concrete elements (e.g. slabs) comprising one or more continuous extended ducts extending therethrough. Optionally, the row of pre-cast concrete elements (e.g. slabs) are substantially held together by one or more (e.g. tensioned) strands extending through the one or more continuous extended ducts.

Optionally, the (e.g. each, e.g. first, e.g. second) pre-cast concrete element (e.g. slab) in the modular concrete building component comprises two or more (e.g. a plurality of) first sides each comprising one or more reinforcement cavities extending therethrough. This allows a pre-cast concrete element (e.g. slab) to be joined to a two or more other pre-cast concrete elements (e.g. slabs) and allows the joins therebetween to be reinforced.

Optionally, the (e.g. each, e.g. first, e.g. second) pre-cast concrete element (e.g. slab) in the modular concrete building component comprises two or more sets of ducts extending through the body of the pre-cast concrete slab. Optionally, each of the sets of ducts comprises one or more ducts arranged substantially in parallel and extending towards a first side. In other words, a set of ducts may be considered to be the one or more ducts that extend between the same sides of a pre-cast concrete slab. Optionally, each set of ducts may comprise two or more ducts at two or more depths relative to the first surface of the pre-cast concrete slab. Optionally, a first set of ducts comprises one or more ducts that extend at an angle relative to the axis of extension of the one or more ducts of a second set of ducts. Optionally, the first set of ducts extend substantially perpendicularly to the second set of ducts.

Optionally, the modular concrete building component comprises two or more pre-cast concrete elements (e.g. slabs) comprising the first pre-cast concrete slab, the second pre-cast concrete slab, and a third pre-cast concrete slab. The third pre-cast concrete element (e.g. slab) may also be considered to be a second first pre-cast concrete element (e.g. slab) or a second second pre-cast concrete slab. The third pre-cast concrete element (e.g. slab) may therefore be considered to comprise:

a body defined by one or more sides, a first surface and a second surface;

one or more reinforcement cavities extending into the body through a first side of the one or more sides; and

a duct extending through the body towards the first side, wherein the duct is configured to receive a strand threaded therethrough.

In such an example comprising three (or more) pre-cast concrete slabs, the first pre-cast concrete element (e.g. slab) may further comprise:

one or more second reinforcement cavity extending into the body through a second side of the one or more sides (e.g. wherein the second side may also be considered to be a second first side); and

one or more second ducts extending through the body towards the second side (or the second first side). Optionally, the duct and the second duct are non-parallel with each other.

Optionally, the third pre-cast concrete element (e.g. slab) is positioned to be adjacent to the first pre-cast concrete element (e.g. slab) such that:

the second side (or the second first side) of the first pre-cast concrete element (e.g. slab) abuts the first side of the third pre-cast concrete slab;

the first surface of the third pre-cast concrete element (e.g. slab) and the extended first surface (e.g. formed by the first surfaces of the first pre-cast concrete element (e.g. slab) and the second pre-cast concrete slab) provides a further extended first surface;

the second surface of the first pre-cast concrete element (e.g. slab) and the extended second surface (e.g. formed by the second surfaces of the first pre-cast concrete element (e.g. slab) and the second pre-cast concrete slab) provides a further extended second surface;

the reinforcement cavity of the third pre-cast concrete element (e.g. slab) is aligned with the second reinforcement cavity of the first pre-cast concrete element (e.g. slab) to provide a second extended reinforcement cavity configured to receive a reinforcement element, optionally wherein the second extended reinforcement cavity is non-parallel with the extended reinforcement cavity formed by positioning the first pre-cast concrete element (e.g. slab) adjacent to the second pre-cast concrete slab; and

the duct of the third pre-cast concrete element (e.g. slab) is positioned proximate to the second duct of the first pre-cast concrete to provide a second extended duct.

As such, in this example, there are two (or more) extended ducts configured to receive a strand with a first duct being formed between a duct of the first pre-cast concrete element (e.g. slab) and a second duct being formed between a second duct of the first pre-cast concrete element (e.g. slab) and a duct of the third pre-cast concrete slab.

It will be appreciated that the features and examples described above for the first side, the reinforcement cavity and the ducts apply equally to the second side, the second reinforcement cavity and the second duct respectively.

Furthermore, optionally the method further comprises:

positioning the third pre-cast concrete element (e.g. slab) adjacent to the first pre-cast concrete element (e.g. slab) such that:

the second side (or the second first side) of the first pre-cast concrete element (e.g. slab) abuts the first side of the third pre-cast concrete slab;

the first surface of the third pre-cast concrete element (e.g. slab) and the extended first surface (e.g. formed by the first surfaces of the first pre-cast concrete element (e.g. slab) and the second pre-cast concrete slab) provides a further extended first surface;

the second surface of the first pre-cast concrete element (e.g. slab) and the extended second surface (e.g. formed by the second surfaces of the first pre-cast concrete element (e.g. slab) and the second pre-cast concrete slab) provides a further extended second surface;

the reinforcement cavity of the third pre-cast concrete element (e.g. slab) is aligned with the second reinforcement cavity of the first pre-cast concrete element (e.g. slab) to provide a second extended reinforcement cavity configured to receive a reinforcement element, optionally wherein the second extended reinforcement cavity is non-parallel with the extended reinforcement cavity formed by positioning the first pre-cast concrete element (e.g. slab) adjacent to the second pre-cast concrete slab; and

the duct of the third pre-cast concrete element (e.g. slab) is positioned proximate to the second duct of the first pre-cast concrete to provide a second extended duct to provide a second extended duct; and

threading a second strand through the second extended duct; and

tensioning the second strand.

The present disclosure thus provides a modular concrete building component formed from a plurality of pre-cast concrete elements (e.g. slabs) and a method of assembling thereof which provides a number of advantages over known systems in the art such as, but not limited to, the ease and speed of assembly and the reduction in material usage due to the need for less concrete.

**Brief Description of the Figures**

Arrangements of the present disclosure will now be described by way of example only and with reference to the accompanying drawings, in which:

Figures 1A-1D shows different views of an example of a pre-cast concrete element;

Figure 2 shows an arrangement of reinforcement cavities;

Figure 3 shows an arrangement of reinforcement cavities;

Figures 4A-4D shows different views of an example of a pre-cast concrete element;

Figure 5 shows a flow diagram of method steps;

Figures 6A-6D schematically represents different steps of a method of providing a modular concrete building component using two pre-cast concrete elements as shown in Figure 1;

Figure 7A-7E schematically represents different steps of a method of providing a modular concrete building component using two pre-cast concrete elements as shown in Figure 4;

Figures 8A-8C schematically represents steps of part of a method of providing a modular concrete building component;

Figures 9A and 9B schematically represents steps of part of a method of providing a modular concrete building component;

Figures 10A-10D schematically represents steps of part of a method of providing a modular concrete building component;

Figure 11 schematically represents part of a modular concrete building component;

Figure 12 schematically represents a modular concrete building component;

Figure 13 schematically represents an example of a modular concrete building component system in accordance with the present disclosure;

Figure 14 schematically represents an example of another modular concrete building component system in accordance with the present disclosure, showing a column interface in detail;

Figure 15 schematically represents an example of another modular concrete building component system in accordance with the present disclosure; and

Figure 16 schematically represents an example of another modular concrete building component system in accordance with the present disclosure, showing a column interface in detail.

**Detailed Description**

The following description presents particular examples and, together with the drawings, serves to explain principles of the disclosure. However, the scope thereof is not intended to be limited to the precise details of the examples, since variations will be apparent to a skilled person and areas deemed to be covered by the description. Terms for components used herein should be given a broad interpretation that also encompasses equivalent functions and features. In some cases, alternative terms for structural features may be provided but such terms are not intended to be exhaustive.

The description herein refers to examples with particular combinations of features, however, it is envisaged that further combinations and cross-combinations of compatible features between examples will be possible whilst still falling within the scope of the appended claims. Indeed, isolated features may function independently from other features and not necessarily require implementation as a complete combination.

Figures 1A and 1B respectively show a perspective view and a top-down view of a pre-cast concrete element in the form of a slab 100. Figures 1C and 1D show cross-sectional slices

of the pre-cast concrete slab 100 through the axes A-A'' and B-B'' shown in Figure 1B respectively.

The pre-cast concrete slab 100 shown has a body 102 defined by four sides 104, a first (or top) surface 106 and a second (or bottom) surface 108, thus forming a cuboid in shape. However, this shape is merely exemplary in nature, and it will be appreciated that the shape of the pre-cast concrete slab 100 is not tied to the other features of the pre-cast concrete 100 slab shown. Indeed, any suitable shape and size of a pre-cast concrete slab is possible.

The pre-cast concrete slab 100 shown has two of first sides 104-1, 104-2, wherein each first side is configured to be positioned adjacent to another pre-cast concrete slab. Both of the first sides 104-1, 104-2 in the example shown have two reinforcement cavities 110 extending through both the first sides 104-1, 104-2 and the first (or top) surface 106. It will however be appreciated that each first side 104-1, 104-2 in the same pre-cast concrete slab 100 need not have the same number of reinforcement cavities 110. As such, the example shown should not be considered limiting in either the number or the arrangement of the reinforcement cavities 110.

The reinforcement cavities 100 each extend through their respective sides 104-1, 104-2 into the body 102 to define a channel which can receive a reinforcement element. As shown in Figures 1B and 1D, the reinforcement cavities 110 of the pre-cast concrete slab 100 have a rectangular cross-sectional shape in the plane parallel to the first side 104-1, 104-2 it extends through and a rectangular cross-sectional shape in the plane parallel to the first surface 106. As such, the reinforcement cavities 110 may be suitable to receive rod or bar reinforcement elements.

The pre-cast concrete slab 100 in this example has only one duct 112 extending between the first sides 104-1, 104-2 (i.e. the duct extends towards each of the first sides 104-1, 104-2). However, the ducts should not be interpreted as always extending between first sides 104-1, 104-2 which are positioned adjacent to another pre-cast concrete slab. However, it will be appreciated that the pre-cast concrete slab 100 could have more than one duct 112, for example, one or more ducts could be arranged to extend perpendicularly to the duct shown and/or a further one or more ducts arranged to extend in parallel with the duct 112 shown.

For example, it might be envisaged that a pre-cast concrete slab at the periphery of a modular concrete building component does not need to be adjoined to another pre-cast

concrete slab and thus there is no need for the side to include a set of reinforcement cavities. However, the duct may still extend through that side to provide an opening through which the strands can be threaded into the duct from the edges of the modular concrete building component. Furthermore, this side may comprise a coupling, clamping or tensioning element that functions to hold the strand under tension after the strand has been tensioned within the extended ducts.

As shown in Figures 1B and 1C, the duct 112 of this example provides a curvilinear pathway through the body 102 of the pre-cast concrete slab 100. From the top down (shown in Figure 1B) the duct 112 extends linearly between the two first sides 104-1, 104-2. When viewed from the side however (as shown in Figure 1C) the duct 112 defines a curved path through the body 102. Thus, when a strand is input into the duct 112, upon tensioning the strand a downwards force, $F_D$ is exerted at the apex of the curve and an upwards force, $F_U$, is exerted at the trough of the curve. As such, it may be advantageous to design the pre-cast concrete slab such that the apex of curve (and resulting downwards force, $F_{D,}$) of a duct 112 or an extended duct (e.g. across multiple pre-cast concrete slabs) is positioned above or proximate to a building column or pillar, and the trough of the curve (and resulting upwards force, $F_U$) of a duct 112 or an extended duct is positioned at a point substantially midway between two columns or pillars.

Figures 2 and 3 show an arrangement of reinforcement cavities 210', 210'', 310', 310'' viewed as a cross-section in a plane parallel to the first side of the pre-cast concrete slab 200, 300 through which the reinforcement cavities 210', 210'', 310', 310'' extend.

In both Figures 2 and 3, the reinforcement cavities shown the reinforcement cavities 210', 210'', 310', 310'' are provided at two different depths $D_1$, $D_2$ relative to the first (e.g. top) surface 206, 306. As such, the reinforcement elements 216, 316 are provided at two different depths within the body 202, 302 of the pre-cast concrete slabs 200, 300. This helps to improve the reinforcement of the pre-cast concrete slabs 200, 300 and, as a result, the join between two pre-cast concrete slabs within a modular concrete building component.

As shown in Figure 2, each of the reinforcement cavities 210', 210'' have a straight portion 211' and a bulbous portion 211'', wherein the reinforcement elements 216 are inserted into the reinforcement cavities 210', 210'' through the straight portion 211' and sit within the bulbous portion 211''. In contrast, the reinforcement cavities 310', 310'' shown in Figure 3 have a straight shape (e.g. with a rectangular cross-section in the plane of the first side).

It will be appreciated that the examples shown in Figures 2 and 3 are exemplary in nature only, and therefore should not be considered limiting with respect to the proximity of the reinforcement cavities 210', 210'', 310', 310'' to one another, the depth of the reinforcement cavities 210', 210'', 310', 310'' or the alternating arrangement of the deeper reinforcement cavities 210' to the shallower reinforcement cavities 210''. Furthermore, a pre-cast concrete slab may comprise a mixture of different shapes of reinforcement cavities 210', 210'', 310', 310''. For example, a single pre-cast concrete slab may have one or more reinforcement cavities 210', 210'' as shown in Figure 2 and one or more reinforcement cavities 310', 310'' and/or reinforcement cavities of any other perceived shape.

Figures 4A and 4B respectively show a perspective view and a top-down view of a pre-cast concrete slab 400. Figures 4C and 4D show cross-sectional slices of the pre-cast concrete slab 100 through the axes A-A'' and B-B'' shown in Figure 4B respectively.

As with the pre-cast concrete slab 100 shown in Figure 1, the pre-cast concrete slab 400 shown in Figure 4 has a body 402 defined by four sides 404, a first (or top) surface 406 and a second (or bottom) surface 408, thus forming a cuboid in shape. However, as described above with respect to Figure 1, this shape is merely exemplary in nature, and it will be appreciated that the shape of the pre-cast concrete slab 400 is not tied to the other features of the pre-cast concrete 400 slab shown. Indeed, any suitable shape and size of a pre-cast concrete slab is possible.

The pre-cast concrete slab 400 shown has two of first sides 404-1, 404-2, wherein each first side is configured to be positioned adjacent to another pre-cast concrete slab. Both of the first sides 404-1, 404-2 in the example shown have two reinforcement cavities 410 extending through both the first sides 404-1, 404-2 and the first (or top) surface 406. It will however be appreciated that each first side 404-1, 404-2 in the same pre-cast concrete slab 400 need not have the same number of reinforcement cavities 410. As such, the example shown should not be considered limiting in either the number or the arrangement of the reinforcement cavities 410.

The reinforcement cavities 400 each extend through their respective sides 404-1, 404-2 into the body 402 to define a channel which can receive a reinforcement element. As shown in Figures 4B and 4D, the reinforcement cavities 410 of the pre-cast concrete slab 400 have a rectangular cross-sectional shape in the plane parallel to the first side 404-1, 404-2 it extends through and a rectangular cross-sectional shape in the plane parallel to the first surface 406. As such, the reinforcement cavities 410 may be suitable to receive rod or bar

reinforcement elements. It will, however, be appreciated that some or all of the reinforcement cavities 410 shown in Figure 4 may be replaced with reinforcement cavities having the shape of the reinforcement cavities 210', 210'' shown in Figure 2 and/or reinforcement cavities having different depths as shown in Figures 2 or 3.

The pre-cast concrete slab 400 in this example has only one duct 412 extending between the first sides 404-1, 404-2 (i.e. the duct extends towards each of the first sides 404-1, 404-2). However, the ducts should not be interpreted as always extending between first sides 404-1, 404-2 which are positioned adjacent to another pre-cast concrete slab. Furthermore, the pre-cast concrete slab 400 may be designed to have any number of ducts extending therethrough as described above in relation to Figure 1.

As shown in Figures 4B and 4C, the duct 412 of this example provides a curvilinear pathway through the body 402 of the pre-cast concrete slab 400. In contrast to the pre-cast concrete slab 100 shown in Figure 1, the duct 412 shown in Figure 4 extends into coupling cavities 414, wherein the coupling cavities 414 extends through both the first sides 404-1, 404-2 and the first surface 406. As such, part of the duct 412' extends out of the body 402 of the pre-cast concrete slab 400 into the coupling cavity 414. However, in the example shown, the duct 412' does not extend past the plane define by the first side 404-1, 404-2.

As with the duct 112 shown in Figure 1, when viewed from the top down, (shown in Figure 4B,) the duct 412 extends linearly between the two first sides 404-1, 404-2. When viewed from the side however (as shown in Figure 4C) the duct 412 defines a curved path through the body 402. Thus, when a strand is input into the duct 412, upon tensioning the strand a downwards force, $F_D$ is exerted at the apex of the curve and an upwards force, $F_U$, is exerted at the trough of the curve. As such, it may be advantageous to design the pre-cast concrete slab such that the apex of curve (and resulting downwards force, $F_D$,) of a duct 412 or an extended duct (e.g. across multiple pre-cast concrete slabs) is positioned above or proximate to a building column or pillar, and the trough of the curve (and resulting upwards force, $F_U$) of a duct 412 or an extended duct is positioned at a point substantially midway between two columns or pillars.

It will however be appreciated that any suitable and/or desirable arrangement of the ducts 112, 412 may be provided through the bodies 102, 402 of the pre-cast concrete slabs 100, 400. For example, the ducts 112, 412 may have a curved pathway when viewed from the top-down (i.e. in contrast to Figures 1B and 4B) and/or a linear pathway when viewed from the side (i.e. in contrast to Figures 1C and 4C). Furthermore, the ducts 112, 412 are not

limited to extending between parallel sides. For example, the ducts 112, 412 could extend diagonally across the body 102, 402 of the pre-cast concrete slabs 100, 400 and/or between two perpendicular or non-parallel sides 104, 404.

Figure 5 shows a flow diagram of method 500 of assembling a modular concrete building component 600, 700 comprising two or more pre-cast concrete slabs (e.g. the pre-cast concrete slabs 100, 400 shown in Figures 1 and 4). Figures 6 and 7 illustrate schematically different stages of the method represented in Figure 5 using the pre-cast concrete slabs 100, 400 shown in Figures 1 (c.f. Figure 6) and Figure 4 (c.f. Figure 7). The following will therefore describe the method 500 of Figure 5 in conjunction with the schematic representations shown in Figures 6 and 7.

Figures 6A/7A and 6B/7B respectively show a perspective view and a top-down view of the modular concrete building component 600, 700 provided by the method 500. Figures 6C/7C and 6D/7D/7E show cross-sectional slices of the pre-cast concrete slab 100 through the axes A-A'' and B-B'' shown in Figures 6B and 7B respectively.

Although both Figures 6 and 7 schematically represent the method 500 using two identical pre-cast concrete slabs 100, 400, the method 500 should not be considered to be so limited. As such, the method 500 may comprise assembling a modular concrete building component 600, 700 from different types of pre-cast concrete slabs.

In a first step, the method 500 comprises positioning 510 a first pre-cast concrete slab 100, 400 adjacent to a second pre-cast concrete slab 100', 400' such that the first side 104-1, 404-1 of the first pre-cast concrete slab 100, 400 abuts the first side 104'-1', 404'-1' of the second pre-cast concrete slab 100, 400.

In so doing, (part of) a modular concrete building component 600, 700 is provided (as shown in Figures 6B and 7B), having an extended first surface 626, 726, an extended second surface (not shown), a plurality of extended reinforcement cavities 620, 720 (shown in Figure 6C and 7C) and an extended duct 622, 722 (as shown in Figures 6B and 6D and Figures 7B, 7D and 7E). The extended reinforcement cavities 720, 720 and the extended ducts 622, 722 extend across the join 628, 728 between the two pre-cast concrete slabs 100, 100', 400, 400'.

In addition to the above, Figure 7B shows that the (part of the) modular concrete building component 700 also includes an extended coupling cavity 724 due to the presence of the

coupling cavities 414 in the pre-cast concrete slabs 400, 400'. As such, when the two pre-cast concrete slabs 400, 400' are positioned adjacent to each other, the ducts 412, 412' which extended into the coupling cavities 414, 414' are positioned proximate to each other to provide the extended duct 722.

Once the two slabs 100, 100', 400, 400' have been positioned adjacent to each other, the method 500 comprises inserting 520 a reinforcement cavity 630, 730 into the extended reinforcement cavities 620, 720 (as shown in Figures 6C and 7C) and threading 530 a strand 740 through the extended ducts 622, 722 (as shown in Figures 7E). The method 500 then includes tensioning 540 the strand 740 within the extended duct 622, 722.

Although Figure 5 shows the inserting step 520 before the threading 530 and tensioning steps 540. It will be appreciated that these steps may be performed in any suitable and/or desirable order. For example, the threading step 530 may occur before the inserting step 520.

Figures 8A-8C schematically represents further method steps that may be performed in addition to those described above and shown in Figures 5-7. For simplicity only, the further method steps are represented using (part of) the modular concrete building component 600 shown in Figure 6. However, it will be appreciated that these steps may be universally applied to any modular concrete building component.

Figure 8A and 8B shows the step of inserting the reinforcement element 730 into an extended reinforcement cavity 720. Once inserted, the reinforcement cavity 720 may be filled with a settable grouting material 735 to enclose and fix the reinforcement element 730 within the reinforcement cavity 720 when the grouting material 735 is set (as shown in Figure 8B). As such, the top surface 735' of the grouting material 735 can be made to be level with the extended first surface formed by the first surfaces 106, 106' of the two pre-cast concrete slabs 100, 100'.

Figures 9A and 9B schematically represents further method steps that may be performed in addition to those described above and shown in Figures 5-8 when at least one of the ducts 112, 412 extends into a coupling cavity. For simplicity only, the further method steps are represented using (part of) the modular concrete building component 700 shown in Figure 7. However, it will be appreciated that these steps may be universally applied to any modular concrete building component comprising a coupling cavity. For example, it would equally

apply if one of the ducts of a first pre-cast concrete slab extends into a coupling cavity, but the duct of the second pre-cast concrete slab it is positioned proximate to does not.

Figure 9A shows the extended coupling cavity 924 and extended duct 722 formed when two pre-cast concrete slabs 400, 400' are positioned adjacent to each other. Once formed, the extended cavity 724 may be filled with a settable grouting material 745 to enclose and fix the ducts 412, 412' within the reinforcement cavity 724 when the grouting material 745 is set (as shown in Figure 9B). As such, the top surface 745' of the grouting material 745 can be made to be level with the extended first surface formed by the first surfaces 406, 406' of the two pre-cast concrete slabs 400, 400'. The grouting 745 may be used to fill the extended coupling cavity 724 before or after a strand is inserted into the extended duct 722.

Figures 10A to 10D schematically represents further method steps that may be performed in addition to those described above and shown in Figures 5-8 when at least one of the ducts 112, 412 extends into a coupling cavity. For simplicity only, the further method steps are represented using (part of) the modular concrete building component 700 shown in Figure 7. However, it will be appreciated that these steps may be universally applied to any suitable modular concrete building component comprising a coupling cavity.

Figure 10A shows the extended coupling cavity 924 and extended duct 722 formed when two pre-cast concrete slabs 400, 400' are positioned adjacent to each other. In this example, a coupling element 742, in the form of a length of ducting, is inserted over the ducts 412, 412' to couple the ducts 412, 412' together and provide a coupled extended duct (shown in Figure 10B).

Once the ducts 412, 412' have been coupled, the extended cavity 724 may be filled with a settable grouting material 745 to enclose and fix the ducts 412, 412' within the reinforcement cavity 724 when the grouting material 745 is set (shown in Figure 10C). As such, the top surface 745' of the grouting material 745 can be made to be level with the extended first surface formed by the first surfaces 406, 406' of the two pre-cast concrete slabs 400, 400'. A strand 740 may then be threaded through the coupled extended duct (as shown in Figure 10D). However, it will be appreciated that the grouting 745 may also be used to fill the extended coupling cavity 724 after a strand has been inserted into the extended duct 722.

Figure 11 shows (part of) a modular concrete building component 900 formed from four pre-cast concrete slabs 800, 800', 800'', 800''', i.e. a first pre-cast concrete slab 800, a second pre-cast concrete slab 800', a third pre-cast concrete slab 800'' and a fourth pre-cast

concrete slab 800'''. As shown, the first pre-cast concrete slab 800 comprises three first sides, or, in other words, the first pre-cast concrete slab 800 is positioned adjacent to three other pre-cast concrete slabs 800', 800'', 800''' (i.e., the second 800', third 800'' and fourth 800''' pre-cast concrete slabs).

In this example, the first pre-cast concrete slab 800 and the second pre-cast concrete slab 800' are similar in arrangement. Each has a first side having two reinforcement cavities 810, 800', which, when the first 800 and second 800' pre-cast concrete slabs are positioned adjacent to each other such that the first sides abut, are aligned to provide two extended reinforcement cavities 820 which extend across the join 828 between the two pre-cast concrete slabs 800, 800'. Reinforcement elements 830 are located within the reinforcement cavities 820 before the reinforcement cavities 820 are filled with a grouting material 835 to secure the reinforcement elements 830 in place. The join 828 between the two pre-cast concrete slabs 800, 800' is thus reinforced.

The same first sides of the first pre-cast concrete slab 800 and the second pre-cast concrete slab 800' both also include three coupling cavities 814, 814' which are similarly aligned to provide three extended coupling cavities 824 extending across the join 828 between the two pre-cast concrete slabs 800, 800'. Each pre-cast concrete slab 800, 800' comprises two ducts 812a, 812' which each extend into one the three coupling cavities 814, 814'. As such, when the first sides are aligned, an extended duct 822 is provided extending through both the first 800 and second 800' pre-cast concrete slabs. The ducts 812a, 812' are coupled, within the extended coupling cavities 824, by a coupling element 842 before the coupling cavities 824 are filled with a grouting material 845 to secure the extended duct 822 in place.

In addition to the first set of three ducts 812 extending towards the join 828 with the second pre-cast concrete slab 800', the first pre-cast concrete slab 800 also includes a second duct 812b (i.e. a second set of ducts comprising one duct) extending through the body of the first pre-cast concrete slab 800 perpendicularly to the first set of ducts 812a. This second duct 812b extends into the extended coupling cavity 824' (formed by aligning the coupling cavity 814 of the first pre-cast concrete slab 800 with the coupling cavity 814'' of the third pre-cast concrete slab 800'') and is coupled, by a coupling element 842', to the second duct 812b'' extending through the third pre-cast concrete slab 800'' to form a second extended duct 822' (perpendicular to the first set of extended ducts 822). The coupling cavity 824' is then filled with a grouting material 845 to secure the extended duct 822' in place.

The join between the first pre-cast concrete slab 800 and the third pre-cast concrete slab 800'' is reinforced by two extended reinforcement cavities 820' including a reinforcement element 830' which are then filled with a grouting material 835'.

The fourth pre-cast concrete slab 800''' comprises a first side that is configured to be positioned adjacent to, and abut, both the first pre-cast concrete slab 800 and the third pre-cast concrete slab 800''. This first side thus comprises five reinforcement cavities 810a''', 810b''' forming two sets, wherein the first set (formed of two reinforcement cavities 810a''') is aligned with the reinforcement cavities 810 of the first pre-cast concrete slab 800 to provide a first set of extended reinforcement cavities 820'', and the second set (formed of three reinforcement cavities 814b''') is aligned with reinforcement cavities 810'' of the third pre-cast concrete slab 800'' to provide a second set of extended reinforcement cavities 820'''. The reinforcement elements 830'', 830''' may then be inserted into the extended reinforcement cavities 820'', 820''' and the extended reinforcement cavities 820'', 820''' may be filled with a grouting material 835'', 835''' to secure the reinforcement elements 830'', 830''' into place.

Similarly, the same first side comprises five coupling cavities 814a''', 814b''' forming two sets, wherein the first set (formed of three coupling cavities 814a''') is aligned with the coupling cavities 814 of the first pre-cast concrete slab 800 to provide a first set of extended coupling cavities 824'', and the second set (formed of two coupling cavities 814b''') is aligned with the coupling cavities 814'' of the third pre-cast concrete slab 800'' to provide a second set of extended coupling cavities 824'''.

The fourth pre-cast concrete slab 800''' further comprises five ducts 812a''', 812b''' which all extend through the body of the pre-cast concrete slab 800''' and into one of the coupling cavities 814a''', 814b'''. These ducts form two sets, wherein the first set (formed of three ducts 812a''') are coupled, by a coupling element 842'', to ducts 812a of the first pre-cast concrete slab 800 to extend the extended duct 822 into the fourth pre-cast concrete slab 800'''. The second set (formed of two ducts 812b''') are coupled, by a coupling element 842''', to ducts 812a'' of the third pre-cast concrete slab 800' to provide an extended duct 822'' through both the fourth 800''' and third 800'' pre-cast concrete slabs. The extended coupling cavities 824'', 824''' may then be filled with a grouting material 845'', 845''' to secure the extended ducts 822, 822'' into place.

Once assembled, strands 840 may be threaded through the extended ducts 822, 822', 822'' and then tensioned, thus holding the plurality of pre-cast concrete slabs 800, 800', 800'', 800''' together.

In this example, the sides of the pre-cast concrete slabs 800, 800', 800'', 800''' which are not shown to be positioned adjacent to another pre-cast concrete slab could form part of the perimeter of the modular concrete building component 900. As such, these sides do not need reinforcement cavities and the ducts extending thereto may be attached to a clamping and/or tensioning means to facilitate the tensioning of the strands and then the holding of that tension once the tensioning means have been removed (i.e. the strands 840 have been cut). Alternatively, these sides may further include reinforcement cavities such that additional pre-cast concrete slabs may be adjoined to form the modular concrete building component 900.

Figure 12 shows a modular concrete building component 1000 formed by a plurality of pre-cast concrete slabs. The modular concrete building component 1000 shown takes the form of a floor/ceiling of a level of a building that is rested atop a plurality of columns 1050.

In a further example, as shown in figure 13, there is provided a modular concrete building component system 1300 comprising one or more concrete building components or slabs 1301. Each such slab 1301 may comprise one or more ducts 1302, such as through-holes, through which tensioning means 1303 may extend. Tensioning means 1303 may include one or more strands or tendons. In some examples, the strands or tendons may include one or more individual wires which may be wound together to form a strand or tendon. In an example, each slab 1301 of the modular concrete building component system 1300 may be positioned in a desired location. Adjacent slabs 1301 may have a grout or other cementitious material layered between opposing surfaces of the slabs 1301. Once positioned appropriately, tensioning means 1303 may be inserted through the ducts 1302 so as to pass through one or more slabs 1301. Each end of the tensioning means 1303 may be affixed to the slab 1301 by an anchorage 1304, 1305. A live end anchorage 1304 may be used at a first end of the tensioning means 1303 and a dead-end anchorage 1305 may be used at a second end, opposite the first end. A dead-end anchorage 1305 may be embedded in the slab or may otherwise be attached and may for example be used at an inaccessible or less accessible end of the duct 1302. A live end anchorage 1304 may be embedded in the slab 1301 or otherwise be attached to the slab 1301 at an accessible end of the duct 1302 and may be used to tension the strands to provide the modular concrete building component system 1300 with its structural stability and strength. Tensioning the strands may involve use

of a hydraulic pump, or other suitable means, to apply a force to pull the stands, placing them under tension. When installing the tendons, anti-burst links may be installed at the back of a stressing anchor (live end anchorage) to prevent the bursting of the concrete while stressing. In some examples, the embedded end of the tensioning means 1303 may be made accessible by providing a recess 1306 or other opening in the slab 1301, which may be located on a surface of the slab 1301.

In such a system 1300, reinforcement means, such as those used in figure 1 for example, may no longer be needed as the structural stability, continuity and strength of the system is provided by placing the tensioning means 1303 under a tensile load, as described above. In other words, placing the strands under a tensile load, which, in turn, applies a compressive load on the one or more slabs 1301 through which the strands extend. In other words, the system or modular concrete building component may be unreinforced, in the traditional sense. That is to say there may be no slab-to-slab reinforcement. Specific applications of reinforcement may be used as set out below. In such a system, each slab 1301 may have one or more ducts 1302 each for accommodating one or more strands, depending on the structural/load bearing qualities required of the structure being built. In some examples, the one or more ducts 1302 may be straight/linear. In other examples, the ducts 1302 may be curved up to, for example, 10 degrees. However, this may vary depending on specific applications and load bearing properties/requirements of the system. In principle, the curve could be any amount including 180 degrees for example for a cantilever slab.

In an example, the system 1300 may further comprise columns 1307, 1308, for example where the system 1300 is intended to be elevated, such as on an elevated floor for a 2-storey building or higher. In some examples, as shown in figure 13 and in more detail in figure 14, the system may further comprise a column coupler section 1309 providing a column-to-slab connection. Such a column coupler section 1309 may comprise a planar section 1310, extending wider than a column 1307, 1308, in a plane perpendicular to the axis of the column 1307, 1308. The planar section 1310 may fit into a corresponding recess 1311 formed in one or more slabs 1301. The planar section 1310 may be formed by pouring concrete into the recess 1311 over such reinforcements, including coupling means, as rebar. For example, the recess 1311 may be entirely contained within one slab 1301, or may extend over all or part of two or more slabs 1301, as shown in figure 15 (recess 1315 in corner, corner of column coupler section shown). The column coupler section 1309 may further comprise a columnar section 1312, corresponding to the shape of the column to which the slab 1301 is to be coupled. Columns may for example be circular or square, as shown in figure 13, or rectangular, or blade shaped as shown in figure 15, as well as any

other typical column shapes used in construction. The column section 1312 of the column coupler section 1309 may accordingly have a shape to match the appropriate column, leading to a suitable connection. In some examples, the column section 1312 may be part of the column.

Such a column coupler section 1309 may comprise, once set, concrete with reinforcement elements 1313, such as rebar, which may be referred to as column connection bars or threaded coupler bars, placed between the columnar section 1312 and the planar section 1311. Such a column coupler section 1309 may reduce the likelihood of damage due to punching shear forces of the column on the slabs 1301, by reinforcing the connection and by helping to distribute the load over a wider area. Column couplers section 1309 may include reinforcement elements 1313 extending, in the planar section 1310 in one or more directions. Blade-shaped columns may for example be located at the edge of a building, or surface formed by the system 1300 comprising one or more slabs 1301. Therefore, a column coupler section 1314 for a blade-shaped column may include reinforcement elements 1313 extending in the planar section 1311 in one direction, or in multiple directions away from, or parallel to, an edge of the building or system 1300, as shown in figure 15. To further strengthen the area around a column-slab interface, the column coupler sections 1309 may comprise one or more punching shear studs 1316, as shown in figure 16, which may for example be connected to or positioned around the reinforcement elements 1313 and which may be combined with post-tensioned strands 1303 to provided added resistance to failure due to punching shear forces around the column.

In some examples, there is provided a method of assembling a modular concrete building component. The modular concrete building component may comprise one or more pre-cast concrete slabs. Each pre-cast concrete slab may comprise a duct extending through the pre-cast concrete slab. The method may comprise positioning a first pre-cast concrete slab adjacent to a second pre-cast concrete slab such that the duct of the first pre-cast concrete slab is positioned proximate to and preferably aligned with the duct of the second pre-cast concrete slab to provide an extended duct. The method may further comprise threading a strand through the extended duct. The method may further comprise tensioning the strand. The duct of each pre-cast concrete slab may extend into a coupling cavity located at a first side of said pre-cast concrete slab. The method may further comprise positioning the first pre-cast concrete slab adjacent to the second pre-cast concrete slab such that a coupling cavity of the first pre-cast concrete slab is aligned with a coupling cavity of the second pre-cast concrete slab to provide an extended coupling cavity into which the duct of the first pre-cast concrete slab and the duct of the second pre-cast concrete slab extends.

In some examples, the duct may extend from one side of a slab to the opposite side. In another example, the duct may extend from the one side to a recess in an upper or lower surface of the slab. One or more recesses may be provided where access to the side of the slab is restricted.

The method may further comprise coupling the duct of the first pre-cast concrete slab to the duct of the second pre-cast concrete slab at a position within the extended coupling cavity using a coupling element to provide a coupled extended duct through which the strand is threaded. In some examples, the tensioning of the strand may be post-tensioning.

The method may further comprise filling the extended coupling cavity with a grouting material to secure the duct of the first pre-cast concrete slab and the duct of the second pre-cast concrete slab within the extended reinforcement cavity. By the above method, post-tensioning may be used to provide continuity to the structure without the need for further reinforcement. Therefore, the pre-cast concrete slab may in some examples consist of concrete only, or may include no structural reinforcement elements, such as rebar. Further, movement between adjacent slabs may be restricted by the post-tensioned strands.

In some examples, there is provided a modular concrete building component. The modular concrete building component may comprise a first pre-cast concrete slab and a second pre-cast concrete slab. The first pre-cast concrete slab and/or the second pre-cast concrete slab may comprise a duct extending therethrough, wherein the duct is configured to receive a strand therethrough. The first pre-cast concrete slab and the second pre-cast concrete slab may be arranged adjacent to each other such that the duct of the first pre-cast concrete slab is positioned proximate to and preferably aligned with the duct of the second pre-cast concrete slab to provide an extended duct configured to receive a common strand extending therethrough. The duct of the or each pre-cast concrete slab may extend into a coupling cavity. When the first pre-cast concrete slab and the second pre-cast concrete slab are arranged adjacent to each other, the coupling cavity of the first pre-cast concrete slab may be aligned with the coupling cavity of the second pre-cast concrete slab to provide an extended coupling cavity to which both the duct of the first pre-cast concrete slab and duct of the second pre-cast concrete slab connect.

In some examples, the modular concrete building component may comprise the strand extending through the duct. The strand may be tensioned to as to apply a compressive force

to the slabs. Applying a tensile force to the strand may be referred to as tensioning or post-tensioning.

The extended coupling cavity of the first pre-cast concrete slab may have a substantially rectangular cross-sectional shape in a plane of a first side of the first pre-cast concrete slab.

The duct of the first pre-cast concrete slab and the duct of the second pre-cast concrete slab may be coupled by a coupling element to provide a coupled extended duct.

The extended coupling cavity may be filled with a grouting material which encloses the coupled extended duct of the first pre-cast concrete slab and the duct of the second pre-cast concrete slab within the extended coupling cavity.

The modular concrete building component may comprise a plurality of first pre-cast concrete slabs and a plurality of second pre-cast concrete slabs arranged to provide a row of pre-cast concrete slabs comprising one or more continuous ducts extending therethrough. The row of pre-cast concrete slabs may be held together by one or more strands extending through the one or more continuous ducts. In some examples, a building component means a component of a building/housing/dwelling or similar. In some examples, there may be provided a combined structural integrity/continuity and movement restriction device, which may be the post-tensioned strands.

There is further provided a building structure comprising one or more modular concrete building components as described above.

There is further provided a modular building component formed by the method as described above.

It is to be understood that the above description is intended to be illustrative, and not restrictive. Many other implementations will be apparent to those of skill in the art upon reading and understanding the above description. Although the disclosure has been described with reference to specific example implementations, it will be recognised that the disclosure is not limited to the implementations described but can be practiced with modification and alteration within the scope of the appended claims. Accordingly, the specification and drawings are to be regarded in an illustrative sense rather than a restrictive sense. The scope of the disclosure should, therefore, be determined with reference to the appended claims, along with the full scope of equivalents to which such claims are entitled.

## CLAUSES

1. A method of assembling a modular concrete building component, the modular concrete building component comprising:

two or more pre-cast concrete slabs, wherein each pre-cast concrete slab comprises:

a body defined by one or more sides, a first surface and a second surface;

a reinforcement cavity extending into the body through a first side of the one or more sides; and

a duct extending through the body towards the first side; and

wherein the method comprises:

positioning a first pre-cast concrete slab adjacent to a second pre-cast concrete slab such that:

the first side of the first pre-cast concrete slab abuts the first side of the second pre-cast concrete slab;

the first surface of the first pre-cast concrete and the first surface of the second pre-cast concrete slab provide an extended first surface;

the second surface of the first pre-cast concrete slab and the second surface of the second pre-cast concrete slab provide an extended second surface;

the reinforcement cavity of the first pre-cast concrete slab is aligned with the reinforcement cavity of the second pre-cast concrete slab to provide an extended reinforcement cavity; and

the duct of the first pre-cast concrete slab is positioned proximate to the duct of the second pre-cast concrete slab to provide an extended duct;

inserting a reinforcement element into the extended reinforcement cavity;

threading a strand through the extended duct; and

tensioning the strand.

2. The method of clause 1, wherein the method does not comprise pouring or covering the extended first surface with a concrete layer to increase the depth of the building component.

3. The method of clause 1 or clause 2, further comprising:

filing the extended reinforcement cavity with a grouting material to secure the reinforcement element within the extended reinforcement cavity.

4. The method of clause 3, wherein the extended reinforcement cavity is filled with the grouting material until the grouting material is substantially level with the extended first surface.

5. The method of any preceding clause, wherein the duct of each pre-cast concrete slab extends into a coupling cavity located at the first side of said pre-cast concrete slab; and

wherein the method further comprises positioning the first pre-cast concrete slab adjacent to the second pre-cast concrete slab such that a coupling cavity of the first pre-cast concrete slab is aligned with a coupling cavity of the second pre-cast concrete slab to provide an extended coupling cavity into which the duct of the first pre-cast concrete slab and the duct of the second pre-cast concrete slab extends.

6. The method of clause 5, further comprising:

coupling the duct of the first pre-cast concrete slab to the duct of the second pre-cast concrete slab at a position within the extended coupling cavity using a coupling element to provide a coupled extended duct through which the strand is threaded.

7. The method of clause 5 or clause 6, further comprising filing the extended coupling cavity with a grouting material to secure the duct of the first pre-cast concrete slab and the duct of the second pre-cast concrete slab within the extended reinforcement cavity.

8. The method of clause 7, wherein, the extended coupling cavity extends through the extended first surface, and the extended coupling cavity is filled with grouting material until the grouting material is level with the extended first surface.

9. A modular concrete building component comprising:

a first pre-cast concrete slab and a second pre-cast concrete slab, wherein both the first pre-cast concrete slab and the second pre-cast concrete slab comprise:

a body defined by one or more sides, a first surface and a second surface;

a reinforcement cavity extending into the body through a first side of the one or more sides; and

a duct extending through the body towards the first side, wherein the duct is configured to receive a strand threaded therethrough; and

wherein the first pre-cast concrete slab and the second pre-cast concrete slab are arranged adjacent to each other such that:

the first side of the first pre-cast concrete slab abuts the first side of the second pre-cast concrete slab;

the first surface of the first pre-cast concrete slab and the first surface of the second pre-cast concrete slab provide an extended first surface;

the second surface of the first pre-cast concrete slab and the second surface of the second pre-cast concrete slab provide an extended second surface;

the reinforcement cavity of the first pre-cast concrete slab is aligned with the reinforcement cavity of the second pre-cast concrete slab to provide an extended reinforcement cavity, wherein the extended reinforcement cavity is configured to receive a reinforcement element; and

the duct of the first pre-cast concrete slab is positioned proximate to the duct of the second pre-cast concrete slab to provide an extended duct configured to receive a common strand extending therethrough.

10. The modular concrete building component of clause 9, wherein the depth of the modular building component is equal to the distance between the extended first surface and the extended second surface.

11. The modular concrete building component of clause 9 or 10, wherein neither the extended first surface nor the extended second surface are covered by a concrete layer.

12. The modular concrete building component of any one of clauses 9 to 11, further comprising a strand extending through both the duct of the first pre-cast concrete slab and the duct of the second pre-cast concrete slab.

13. The modular concrete building component of any one of clauses 9 to 12, wherein the extended reinforcement cavity is a groove formed through the extended first surface.

14. The modular concrete building component of clause 14, wherein the groove has a substantially rectangular cross-sectional shape in the plane perpendicular to the extended first surface.

15. The modular concrete building component of any one of clauses 9 to 14, further comprising a reinforcement element received within the extended reinforcement cavity such that the reinforcement element extends into both the first pre-cast concrete slab and the second pre-cast concrete slab.

16. The modular concrete building component of clause 15, wherein the reinforcement element is a metal rod or bar.

17. The modular concrete building component of clause 15 or 16, further comprising a grouting material within the extended reinforcement cavity, wherein the grouting material encloses the reinforcement element and is configured to fix the reinforcement element within the extended reinforcement cavity.

18. The modular concrete building component of clause 17 when dependent on clause 14, wherein the grouting material fills the reinforcement cavity such that the top surface provided by the grouting material is substantially level with the extended first surface.

19. The modular concrete building component of any one of clauses 9 to 18, wherein the first side of the first pre-cast concrete slab and the first side of the second pre-cast concrete slab each comprise a plurality of reinforcement cavities such that, when the first pre-cast slab is adjacent to the second pre-cast slab, a plurality of extended reinforcement cavities is provided.

20. The modular concrete building component of clause 19, wherein the plurality of extended reinforcement cavities are configured to receive two or more reinforcement elements at two or more depths relative to the extended first surface.

21. The modular concrete building component of any one of clauses 9 to 20, further comprising a coupling element configured to couple the duct of the first pre-cast concrete slab to the duct of the second pre-cast concrete slab, thus providing a coupled extended duct configured to receive a strand.

22. The modular concrete building component of clause 21, wherein the coupling element comprises a length of ducting that is configured to wrap around part of the duct of the first pre-cast concrete slab and part of the duct of the second pre-cast concrete slab.

23. The modular concrete building component of clause 21 or 22, wherein the coupling element comprises a layer of tape.

24. The modular concrete building component of any one of clauses 9 to 23, wherein the duct of each pre-cast concrete slab extends into a coupling cavity located at the first side of said pre-cast concrete slab; and

wherein, when the first pre-cast concrete slab and the second pre-cast concrete slab are arranged adjacent to each other, the coupling cavity of the first pre-cast concrete slab is

aligned with the coupling cavity of the second pre-cast concrete slab to provide an extended coupling cavity into which both the duct of the first pre-cast concrete slab and duct of the second pre-cast concrete slab extend.

25. The modular concrete building component of any one of clauses 24, wherein the extended coupling cavity of the first pre-cast concrete slab has a substantially rectangular cross-sectional shape in the plane of the first side.

26. The modular concrete building component of any one of clauses 24 or 25, wherein the extended coupling cavity is accessible through the extended first surface.

27. The modular concrete building component of any one of clauses 24 to 26, wherein the duct of the first pre-cast concrete slab and the duct of the second pre-cast concrete slab are coupled by a coupling element to provide a coupled extended duct, and the extended coupling cavity is filled with a grouting material which encloses the coupled extended duct of the first pre-cast concrete slab and duct of the second pre-cast concrete slab within the extended coupling cavity.

28. The modular concrete building component of any one of clauses 9 to 27, wherein the first side of the first precast concrete slab and the first side of the second pre-cast concrete slab both comprise a plurality of first coupling cavities.

29. The modular concrete building component of any one of clauses 9 to 28, wherein the duct of the first pre-cast concrete slab and the duct of the second pre-cast concrete slab each extend from their respective first sides to another side to provide an extended duct across first pre-cast concrete slab and the second pre-cast concrete slab.

30. The modular concrete building component of any one of clauses 9 to 29, wherein the duct of the first pre-cast concrete slab and the duct of the second pre-cast concrete slab are both metal ducts.

31. The modular concrete building component of any one of clauses 9 to 31, wherein the first pre-cast concrete slab and the second pre-cast concrete slab each comprise a plurality of ducts extending through the body's thereof, wherein each duct of the plurality of ducts may be configured to be parallel or perpendicular to another duct of the plurality of ducts.

32. The modular concrete building component of any one of clauses 9 to 31, further comprising a third pre-cast concrete slab, wherein the first pre-cast concrete slab further comprises:

a second reinforcement cavity extending into the body through a second side of the one or more sides; and

a second duct extending through the body towards the second side, wherein the duct and the second duct are non-parallel with each other;

wherein the third pre-cast concrete slab is positioned to be adjacent to the first pre-cast concrete slab such that:

the second side of the first pre-cast concrete slab abuts the first side of the third pre-cast concrete slab;

the first surface of the third pre-cast concrete slab and the extended first surface provides a further extended first surface;

the second surface of the first pre-cast concrete slab and the extended second surface provides a further extended second surface;

the reinforcement cavity of the third pre-cast concrete slab is aligned with the second reinforcement cavity of the first pre-cast concrete slab to provide a second extended reinforcement cavity configured to receive a reinforcement element,

wherein the second extended reinforcement cavity is non-parallel with the extended reinforcement cavity formed by positioning the first pre-cast concrete slab adjacent to the second pre-cast concrete slab; and

the duct of the third pre-cast concrete slab is positioned proximate to the second duct of the first pre-cast concrete to provide a second extended duct.

33. The modular concrete building component of any one of clauses 9 to 32, comprising a plurality of first pre-cast concrete slabs and a plurality of second pre-cast concrete slabs arranged to provide a row of pre-cast concrete slabs comprising one or more continuous duct extending therethrough;

wherein the row of pre-cast concrete slabs are held together by one or more strands extending through the one or more continuous ducts.

34. A building foundation/structure comprising a modular building component formed from the modular concrete building component as set out in any one of clauses 9-33.

35. A modular building component formed from the method as set out in any one of clauses 1-8.

## CLAIMS

1. A method of assembling a modular concrete building component, the modular concrete building component comprising:

two or more pre-cast concrete slabs, wherein each pre-cast concrete slab comprises:

a duct extending through the pre-cast concrete slab; and

wherein the method comprises:

positioning a first pre-cast concrete slab adjacent to a second pre-cast concrete slab such that the duct of the first pre-cast concrete slab is positioned proximate the duct of the second pre-cast concrete slab to provide an extended duct;

threading a strand through the extended duct; and

tensioning the strand, wherein

the duct of each pre-cast concrete slab extends into a coupling cavity located at a first side of said pre-cast concrete slab; and

wherein the method further comprises:

positioning the first pre-cast concrete slab adjacent to the second pre-cast concrete slab such that a coupling cavity of the first pre-cast concrete slab is aligned with a coupling cavity of the second pre-cast concrete slab to provide an extended coupling cavity into which the duct of the first pre-cast concrete slab and the duct of the second pre-cast concrete slab extends.

2. The method of claim 1, further comprising:

coupling the duct of the first pre-cast concrete slab to the duct of the second pre-cast concrete slab at a position within the extended coupling cavity using a coupling element to provide a coupled extended duct through which the strand is threaded.

3. The method of claim 1 or claim 2, further comprising:

filling the extended coupling cavity with a grouting material to secure the duct of the first pre-cast concrete slab and the duct of the second pre-cast concrete slab within the extended tendon coupler cavity.

4. A modular concrete building component comprising:

a first pre-cast concrete slab and a second pre-cast concrete slab, wherein each of the first pre-cast concrete slab and the second pre-cast concrete slab comprise:

a duct extending therethrough, wherein the duct is configured to receive a strand therethrough; and

wherein the first pre-cast concrete slab and the second pre-cast concrete slab are arranged adjacent to each other such that:

the duct of the first pre-cast concrete slab is positioned proximate the duct of the second pre-cast concrete slab to provide an extended duct configured to receive a common strand extending therethrough, wherein

the duct of each pre-cast concrete slab extends into a coupling cavity; and

wherein, when the first pre-cast concrete slab and the second pre-cast concrete slab are arranged adjacent to each other, the coupling cavity of the first pre-cast concrete slab is aligned with the coupling cavity of the second pre-cast concrete slab to provide an extended coupling cavity to which both the duct of the first pre-cast concrete slab and duct of the second pre-cast concrete slab connect.

5. The modular concrete building component of claim 4, wherein the extended coupling cavity of the first pre-cast concrete slab has a substantially rectangular cross-sectional shape in a plane of a first side of the first pre-cast concrete slab.

6. The modular concrete building component of claim 4 or claim 5, wherein the duct of the first pre-cast concrete slab and the duct of the second pre-cast concrete slab are coupled by a coupling element to provide a coupled extended duct.

7. The modular concrete building component of claim 6, wherein the extended coupling cavity is filled with a grouting material which encloses the coupled extended duct of the first pre-cast concrete slab and the duct of the second pre-cast concrete slab within the extended coupling cavity.

8. The modular concrete building component of any one of claims 4 to 7, comprising a plurality of first pre-cast concrete slabs and a plurality of second pre-cast concrete slabs arranged to provide a row of pre-cast concrete slabs comprising one or more continuous ducts extending therethrough;

wherein the row of pre-cast concrete slabs are held together by one or more strands extending through the one or more continuous ducts.

9. A building structure comprising one or more modular concrete building components as defined in any of claims 4 to 8.

10. A modular building component formed by the method as defined in any one of claims 1-3.