

CONSTRUCTION ELEMENTS AND METHODS OF CONSTRUCTION

FIELD OF THE INVENTION

5 The invention relates to construction elements and methods of construction. In particular, the invention relates to pre-cast, cementitious construction elements and methods of construction using such elements.

BACKGROUND TO THE INVENTION

10 Conventional building techniques often employ precast structural elements for the construction of walls, floors and the like. One of the difficulties associated with the use of precast elements is that of accurately positioning the elements to produce a true and level wall or floor.

 Another drawback of using conventional precast structural elements is the
15 time required to construct the wall or floor. This is partially due to the aforementioned problem of accurately positioning the elements and other alignment problems caused by irregularities in the precast elements. Delays in constructing a wall or floor prevents higher walls and floors being constructed and/or other features of a building being installed. This results in projects falling
20 behind schedule and costly fines being levied against those responsible. This is exacerbated in large projects such as high-rise buildings with many floors.

 A further difficulty is the danger associated with transporting the elements, e.g. around a building site. The structural elements are typically moved with the aid of clutches that grip the element. Accidents have occurred where the

clutches have given way or the integrity of the precast material has been compromised. Consequently, health and safety regulations have proscribed that chains must be employed when transporting the elements, which adds to the time taken to form a structure with conventional precast elements.

5 In this specification, the terms “comprises”, “comprising” or similar terms are intended to mean a non-exclusive inclusion, such that a method, system or apparatus that comprises a list of elements does not include those elements solely, but may well include other elements not listed.

10 OBJECT OF THE INVENTION

It is an object of the present invention to address or at least ameliorate one or more of the aforementioned problems associated with the prior art or to provide a useful commercial alternative.

It is a preferred object of the present invention to provide a construction
15 element that is simpler to use than prior art construction elements and a method
of construction that reduces construction times compared with the prior art
construction methods.

SUMMARY OF THE INVENTION

20 In one form, although it need not be the only or indeed the broadest form,
the invention resides in a pre-cast cementitious construction element comprising:
a body;
at least one coupling member protruding from an edge of the body; and,
at least one coupling member provided at an opposed edge of the body,

said at least one coupling member protruding from an edge being adapted to couple with a coupling member at an opposed edge of an adjacent pre-cast construction element such that, when coupled, a spaced relationship exists between said pre-cast construction element and said adjacent pre-cast construction element.

Suitably, the coupling members are metal plates extending from the edge and the opposed edge of the body, which are preferably partially embedded in the body.

Suitably, the construction element further comprises reinforcing members welded to the metal plates.

Preferably, the reinforcing members are completely embedded in the body and may be u-shaped.

The at least one coupling member protruding from an edge of the body may be a rod, which is preferably at least partially embedded in the body.

The construction element may further comprise a bearing plate provided around the rod at the edge of the body.

Suitably, the at least one coupling member provided at an opposed edge of the body comprises a socket extending into the body.

Suitably, the socket comprises a hollow tube embedded in the body.

The at least one coupling member provided at an opposed edge of the body may further comprise a hollow receiving tube at least partially embedded in the body.

Preferably, a longitudinal axis of the hollow tube is aligned with a longitudinal axis of the socket.

The construction element may further comprise a conduit extending between opposed faces of the body through each said socket.

Suitably, the construction element further comprises a bearing plate provided at the opposed edge of the body around an aperture of said socket.

5 Optionally, the at least one coupling member protruding from an edge of the body further comprises a hollow tube at least partially embedded in the body.

Preferably, a longitudinal axis of the hollow tube is aligned with a longitudinal axis of the rod.

10 The construction element may further comprise a conduit extending between opposed faces of the body at the base of each said rod.

The construction element may further comprise a bearing plate provided on a free end of the hollow receiving tube, said bearing plate having an aperture therethrough.

15 The construction element may further comprise at least one conduit extending between a base of the socket and an edge of the body.

Suitably, the coupling members are I-beams.

20 Suitably, the at least one coupling member protruding from an edge of the body and the at least one coupling member provided at an opposed edge of the body is an I-beam embedded in the body, said I-beam extending between an edge of the body and an opposed edge of the body.

The construction element may further comprise a bearing plate provided on an end of each said I-beam.

Optionally, the construction element may further comprise a channel extending between an edge of the body and an opposed edge of the body.

Suitably, the at least one coupling member protruding from an edge of the body comprises at least one reinforcing member, which is embedded in said body and preferably extends substantially toward an opposed edge of the body.

5 The construction element may further comprise at least one substantially u-shaped bar protruding from an edge of the body.

The construction element may further comprise at least one substantially u-shaped bar protruding from an opposed edge of the body.

10 Suitably, when the pre-cast construction element is coupled to said adjacent pre-cast construction element, the at least one substantially u-shaped bar protruding from an opposed edge of the body of said pre-cast construction element is substantially aligned with at least one substantially u-shaped bar protruding from an edge of the body of said adjacent pre-cast construction element.

15 The substantially u-shaped bars may be substantially aligned with a central axis of an edge and/or an opposed edge of the body. Alternatively, the substantially u-shaped bars may be substantially perpendicular to the central axis of an edge and/or an opposed edge of the body.

Optionally, the construction element may further comprise at least one adjustable bolt for adjusting a position of the construction element.

20 In another form, although again not necessarily the broadest form, the invention resides in a method of construction using pre-cast cementitious construction elements, each said construction element comprising:

a body;

at least one coupling member protruding from an edge of the body; and,

at least one coupling member provided at an opposed edge of the body, said at least one coupling member protruding from an edge being adapted to couple with a coupling member at an opposed edge of an adjacent pre-cast construction element;

5 said method including the step of coupling a pre-cast construction element to an adjacent pre-cast construction element such that a spaced relationship exists between said pre-cast construction element and said adjacent pre-cast construction element.

10 The method preferably further includes the step of constructing at least part of a floor structure in a space between said pre-cast construction element and said adjacent pre-cast construction element.

The method may further include the step of supporting the adjacent pre-cast construction element with at least one prop.

15 Preferably, the coupling step includes welding together the at least one coupling member protruding from an edge of the body and the at least one coupling member provided at an opposed edge of the body.

20 The method may further include the step of removing at least one prop supporting the adjacent pre-cast construction element once the at least one coupling member protruding from an edge of the body and the at least one coupling member provided at an opposed edge of the body have been welded together to leave a free-standing adjacent pre-cast construction element.

Optionally, the coupling step includes inserting the at least one coupling member of said construction element into the at least one coupling member of said adjacent construction element.

Optionally, the coupling step includes inserting at least one rod of said construction element into a socket extending into the body of said adjacent construction element.

5 Suitably, the at least one rod is inserted until a bearing plate provided around said rod on said construction element abuts a hollow tube aligned with said socket of an adjacent construction element.

Suitably, the at least one rod is inserted until a hollow tube aligned with said rod on said construction element abuts a bearing plate provided around said socket of an adjacent construction element.

10 Optionally, the coupling step includes abutting an end of at least one I-beam of said construction element with a bearing plate provided at an end of an I-beam of said adjacent construction element.

15 The coupling step may include aligning at least one u-shaped bar protruding from an edge of the body of said construction element substantially parallel with at least one u-shaped bar protruding from an opposed edge of an adjacent construction element.

20 The coupling step may include aligning a pair of u-shaped bars protruding from an edge of the body of said construction element substantially parallel with and between a pair of u-shaped bars protruding from an opposed edge of an adjacent construction element.

The method may further include the step of running reinforcing members through said substantially aligned u-shaped bars.

The method may further include the step of filling said socket with settable material.

The method may further include the step of guiding the adjacent construction element into position with the aid of at least one positioning shoe.

Suitably, the method further includes the step of affixing a collar to the coupling member protruding from an edge of the body and abutting said positioning shoe against said collar.

Suitably, the method further includes the step of temporarily supporting said adjacent construction element with a prop coupled to a base, said base abutting the positioning shoe.

The method may further include the step of coupling a working platform to the construction element via a conduit in said construction element.

The coupling step may include welding together the at least one coupling member protruding from an edge of the body and the at least one coupling member protruding from a foundation.

The method may further include the step of filling a volume around the at least one coupling member protruding from an edge of the body and the at least one coupling member protruding from the foundation with settable material.

Suitably, the step of filling includes pouring settable material through a channel in the construction element.

In a further form, although again not necessarily the broadest form, the invention resides in a building system for a multi-storey construction comprising:

a plurality of pre-cast cementitious construction elements, each said construction element comprising:

a body,

at least one coupling member protruding from an edge of the body; and,

at least one coupling member provided at an opposed edge of the body,
said at least one coupling member protruding from an edge being adapted
to couple with a coupling member at an opposed edge of an adjacent pre-
cast construction element such that, when coupled, a spaced relationship
5 exists between said pre-cast construction element and said adjacent pre-
cast construction element; and

a plurality of floor structures, each said floor structure extending through a
space between one of said pre-cast construction elements and an adjacent pre-
cast construction element.

10 In a yet further form, although again not necessarily the broadest form,
the invention resides in a base for the aforementioned pre-cast cementitious
construction element, said base comprising:

a plate supported by a foundation; and

at least one coupling member protruding from said plate, said at least one
15 coupling member adapted to couple with at least one coupling member
protruding from an edge of said construction element.

In another form, the invention resides in a method of joining the
aforementioned pre-cast cementitious construction elements, said method
including the steps of:

20 welding together reinforcing members of a construction element and an
adjacent construction element; and

filling a space between said constructions elements with settable material.

In a yet further form, the invention resides in a structure comprising the
aforementioned pre-cast cementitious construction elements.

Further features and forms of the present invention will become apparent from the following detailed description.

BRIEF DESCRIPTION OF THE DRAWINGS

5 By way of example only, preferred embodiments of the invention will be described more fully hereinafter with reference to the accompanying drawings, wherein:

FIG 1 is a schematic front elevation of a pre-cast construction element in accordance with an embodiment of the invention;

10 FIG 2 is a schematic front elevation of a pre-cast construction element in accordance with an alternative embodiment of the invention;

FIG 3 is a schematic side elevation of two coupled pre-cast construction elements;

15 FIG 4 is an enlarged schematic side view of a socket of the construction element shown in FIG 1;

FIG 5 is a schematic plan view of the socket of FIG 1 and a bearing plate of the construction element shown in FIG 1;

FIG 6 shows schematically an alternative embodiment of a receiving tube of the construction element shown in FIG 1;

20 FIG 7 shows schematically a further alternative embodiment of the receiving tube;

FIG 7A shows schematic front and side elevations of coupled pre-cast construction elements in accordance with an alternative embodiment of the invention;

FIG 8 shows schematic front and side elevations of the pre-cast construction element shown in FIG 1 and a method of construction in accordance with an embodiment of the invention;

FIG 9 is a schematic front elevation of an alternative method of construction to that shown in FIG 8 employing a positioning frame;

FIG 10 is a schematic plan view of the positioning frame of FIG 9;

FIG 11 is a schematic front elevation showing a base and the commencement of the construction method according to an embodiment of the present invention;

FIG 12 is a schematic side elevation of positioning shoes and collars employed in the method of construction shown in FIG 8;

FIG 13 is a schematic plan view of the positioning shoes and collars of FIG 12;

FIG 14 is a schematic side elevation showing an extending base and a push-pull prop employed in the method of construction shown in FIG 8;

FIG 15 is a schematic side elevation of an alternative embodiment of the positioning shoes;

FIG 15A shows schematically front and side elevations of two pre-cast construction elements and supports for the upper, adjacent construction element;

FIG 16 is a schematic front elevation of the pre-cast construction element of FIG 1 and a lifting apparatus therefor;

FIG 17 is a schematic side elevation of the pre-cast construction element and lifting apparatus of FIG 16;

FIG 18 is a schematic side elevation of a plurality of working platforms attached to an outside of a vertical wall constructed from the elements of FIG 1 using the method of construction in accordance with an embodiment of the invention;

5 FIG 19 is a schematic front elevation of FIG 18;

FIG 20 is a schematic plan view of an embodiment of a lift core according to one embodiment constructed from embodiments of the pre-cast construction elements of the present invention;

10 FIG 21 is a schematic plan view of an embodiment of a stair core according to one embodiment constructed from embodiments of the pre-cast construction elements of the present invention;

FIG 22 is a schematic plan view of stitch welding between adjacent elements in the cores shown in FIGS 20 and 21;

15 FIG 23 is a schematic plan view of some of the pre-cast construction elements of FIG 21;

FIG 24 is a schematic plan view showing pre-cast construction elements according to an embodiment of the invention joined using conventional formwork;

20 FIG 24A is a schematic plan view showing a method of joining adjacent pre-cast construction elements according to an embodiment of the invention;

FIG 25 is a schematic side elevation showing the method of construction of walls and stairs according to an embodiment of the present invention;

FIG 26 is a schematic side elevation showing an alternative method of construction of walls and stairs according to an embodiment of the present invention;

FIG 27 is a schematic front view showing a method of joining horizontal
5 pre-cast floor elements according to an embodiment of the present invention;

FIG 28 is a schematic view showing an alternative method of construction to the method shown in FIG 27;

FIG 28A is a schematic plan view showing a method of joining vertical pre-cast wall elements according to an embodiment of the present invention;

10 FIG 28B is a schematic plan view showing further details of the method shown in FIG 28A;

FIG 29 is a schematic front elevation of an alternative pre-cast construction element in accordance with another embodiment of the invention;

15 FIG 30 is a schematic front elevation of two pre-cast construction elements of the type shown in FIG 29 and the associated method of construction according to an embodiment of the present invention;

FIG 31 is a schematic side elevation showing the positioning of the pre-cast construction elements of the type shown in FIG 29;

20 FIG 32 shows schematically front and side elevations of a pre-cast construction element in accordance with another embodiment of the present invention and the associated method of construction using conventional formwork at the base of the pre-cast element;

FIG 33 is a schematic front elevation showing an alternative method of positioning the pre-cast construction element of FIG 1 after a floor is poured;

FIG 34 is a schematic plan view of a rebate plate for the construction element shown in FIG 33;

FIG 35 is an enlarged schematic view of the rebate plate and receiving tube of FIG 33;

5 FIG 36 is a schematic plan view of a pre-cast construction element comprising multiple receiving tubes in accordance with another embodiment of the invention;

FIG 37 is a schematic plan view of an embodiment of the pre-cast element comprising adjustable bolts;

10 FIG 38 is a schematic front elevation of FIG 37;

FIG 39 is a schematic front elevation of a plurality of the elements of FIG 37 coupled together;

15 FIG 40 is a schematic plan view of a mould for horizontal moulding of the pre-cast construction element of FIG 2 according to an embodiment of the invention;

FIG 41 is a schematic side elevation showing an alternative method of creating conduits in the pre-cast construction elements;

20 FIG 42 is a schematic front elevation of a mould for vertical moulding of the pre-cast construction element of FIG 2 according to an embodiment of the invention;

FIG 43 is an isometric view of a vertically cast construction element according to an embodiment of the invention;

FIG 44 is a schematic front elevation of a pre-cast construction element in accordance with another alternative embodiment of the invention;

FIG 45 is a schematic plan view of the bearing plate, tube and coupling member of FIG 44;

FIG 46 is a schematic front elevation of a pre-cast construction element in accordance with a further alternative embodiment of the invention;

5 FIG 47 is a schematic front elevation of a pre-cast construction element in accordance with a yet further alternative embodiment of the invention;

FIG 48 is a schematic plan view of the element of FIG 47 showing positions of u-shaped bars protruding from the first and second sides of the element;

10 FIG 49 is a schematic front elevation of a pre-cast construction element in accordance with another alternative embodiment of the invention;

FIG 50 is a schematic plan view of the element of FIG 49 showing positions of u-shaped bars protruding from the first and second sides of the element;

15 FIG 51 is a schematic front elevation of a pre-cast construction element and an alternative embodiment of the lifting apparatus shown in FIG 16;

FIG 52 is a schematic partial front elevation showing an alternative embodiment of the receiving tube; and

20 FIG 53 shows another schematic view of the corrugated tube and receiving tube.

DETAILED DESCRIPTION OF THE INVENTION

Referring to FIGS 1-7, in accordance with an embodiment of the invention, a pre-cast cementitious construction element 10, is provided,

comprising a body 12 and at least one coupling member 14 protruding from an edge 16 of the body. At least one coupling member 18 is provided at an opposed edge 20 of the body, the coupling member 18 adapted to couple with a coupling member 14 of an adjacent pre-cast construction element 10b such that, when coupled, a spaced relationship exists between the pre-cast construction element 10 and the adjacent pre-cast construction element 10b.

In this embodiment, coupling members 18 are in the form of sockets 18 adapted to receive coupling members 14, which, in this embodiment, are in the form of steel rods 14. In the embodiment shown in FIG 1, two coupling members 14 are provided, which are partially embedded in the body 12 to a depth that is greater than the length of rod protruding from the body. The number of rods 14, the particular depth of embedding, the length of protrusion from the body 12 and the diameter of the rods 14 will vary depending on the application of the pre-cast construction element 10. In the embodiment shown in FIG 2, three rods 14 extend from edge 16 and three sockets 18 are provided at the opposed edge 20 extending into the body 12. In the embodiment shown, the body 12 is reinforced with reinforcing members 22 as is known in the art, except that in the embodiment shown, the reinforcing members 22 do not protrude from the edges 16, 20 of the body 12.

Referring to FIG 3, a securing means 24 is attached to the body 12. Securing means 24 is in the form of a metal bearing plate 24 having an aperture 26 through which rod 14 can pass. Bearing plate 24 is secured to the first edge 16 of the body 12 with the aid of rods or bars 28 welded to the plate 24 and embedded in the body 12.

With further reference to FIGS 4 and 5, on opposed edge 20 of the body 12, sockets 18 are in the form of hollow tubes 30, which are embedded in body 12. Tubes 30 are sized to receive rods 14 of an adjacent element 10b and in one embodiment the tubes 30 are in the form of hollow, corrugated, steel tubes.

5 Prior to casting the elements 10, a transverse conduit 32 is formed in tube 30 by placing an insert (not shown) transversely through holes in the tube and filling approximately 100mm at the bottom of the tube 30 with non-shrink grout 34. Conduit 32 is also shown in FIGS 1 and 2.

A hollow receiving tube 36 is placed over an end of the corrugated tube 10 30, as shown in FIGS 4 and 5. In one embodiment, receiving tube 36 comprises a bearing plate 38 and a bottom plate 40 joined by three rods 42. Plates 38, 40 have apertures therethrough to enable the receiving tube 36 to be placed onto the end of hollow tube 30 and welded in position. Receiving tubes 36 are partially embedded in body 12 and partially protrude from opposed edge 20, as 15 shown in FIGS 1 and 2. The purpose of the bearing plate 38 will be apparent from the description of the method of coupling two elements 10 below.

With reference to FIGS 6 and 7, alternative embodiments of the receiving tube 36 comprise the receiving tube 36 extending the full length of the corrugated tube 30 with bottom plate 40 welded to the bottom of the corrugated 20 tube 30 and a nut or washer 44 or the like welded to the bottom plate 40 through which a bolt may pass during casting of the element and to aid positioning of the element as described in more detail later herein.

Two pre-cast construction elements 10 are coupled together by inserting the rods 14 of one element into sockets 18 of an adjacent element. Prior to

insertion of the rods 14, sockets 18 are filled with grout, such as 50-60 MPa liquid, non-shrink grout, which is displaced by the rods 14 when inserted. The rods 14 are inserted to their full extent at which point bearing plate 38 abuts plate 24, as shown, for example, in FIG 3. Plates 38 and 24 are stitch welded
5 together to keep the elements 10 in place while the grout sets, which typically requires about 1-2 hours. After such time the elements 10 will remain securely in place. This arrangement leaves a space 46 between adjacent construction elements 10 for a floor structure to be constructed, which can also be constructed from the pre-cast construction elements 10 of the present invention.

10 FIG 7A shows an alternative embodiment of the construction element 10. In the embodiment shown, two coupling members 14 extend from the edge 16 of the body 12 and two coupling members 18 extend from the opposed edge 20 of the body 12. In this embodiment, the coupling members 14, 18 are in the form of metal plates, preferably steel of the required grade commonly used in the art.
15 Each metal plate 14, 18 is welded to a reinforcing member 15 in the form of a steel rod. In this embodiment, the steel rod is formed into a u-shape. The u-shaped rods 15 are completely embedded in the cementitious body 12 and at least part the metal plates are embedded in the body 12. In the embodiment shown in FIG 7A, construction element 10 also comprises u-shaped bars 240
20 partially embedded in the body 12 and protruding from edge 16 and/or opposed edge 20. When construction elements 10a, 10b are in position, and coupling members 14, 18 are welded together, u-shaped bars overlap in space 46 between the elements. Reinforcing members 300 are passed through u-shaped bars 240 to provide a complete "development bar" throughout the structure.

Although not shown in FIG 7A, construction element 10a and adjacent construction element 10b also comprise reinforcing members 22 embedded in the body 12, as shown in the embodiments of FIGS 1 and 2.

The method of construction will now be described in further detail with reference to FIG 8 onwards. Although the method will primarily be described in relation to the embodiment of the construction element 10 comprising coupling members in the form of rods 14 and sockets 18, the method, in general, is equally applicable to the alternative embodiments of the construction elements 10 described herein.

Referring to FIG 8, once the rods 14 of an upper, adjacent element 10b have been fully inserted into the hollow receiving tubes 30 of a lower, element 10a such that plates 24 are in contact with bearing plates 38, temporary props 48 are attached to adjacent element 10b to ensure the upper, adjacent element cannot topple when support provided by a crane (not shown) holding the adjacent element is removed. The bottom of the adjacent element 10b is then accurately positioned with the aid of positioning shoes 50. Positioning shoes 50 are attached to a collar 51 or to receiving tubes 36, which will be described in more detail hereinafter. When the upper, adjacent element 10b has been plumbed in position, for example, by laser plumbing known in the art, plates 24 and bearing plates 38 are welded together. Once the welds have cooled, the props 48 supporting the adjacent pre-cast construction element 10b are removed to leave a free-standing adjacent pre-cast construction element 10b. Alternatively, the props 48 may remain in place until they need to be removed, for example, to provide the required access.

For the alternative embodiment of the construction element 10 shown in FIG 7A, collars 51 of the positioning shoes 50 fit around the metal plates protruding from edges 16, 20 of the body 12.

5 An alternative method of construction is shown in FIGS 9 and 10, which employs a hinged element-positioning frame 52. Positioning frame 52 is placed and secured in position and the adjacent element is lowered within frame 52 into contact with the lower construction element 10 as described above. Temporary push-pull props 54 are strategically placed according to the size and shape of the element 10 and are adjusted as required to plumb the element 10. Both of
10 the aforementioned construction methods can be used for the construction of both walls and columns where a reinforced concrete floor has been poured.

With reference to FIG 11, commencement of the construction method according to an embodiment of the invention using the elements 10 of the present invention will now be described. A steel plate 56 is cast into a concrete
15 foundation 58 and fixed with adjustable bolts 59 such that the height can be adjusted as required. A pair of oversized receiving tubes 60, similar to receiving tubes 30, are welded to plate 56, ready to receive the rods 14 of the first element 10. The oversized receiving tubes 60 allow a greater degree of movement of the first element 10 than the regular sized receiving tubes 30 in the event that
20 there is any movement during the initial pour. Once the first pre-cast element 10 is correctly positioned and the reinforced concrete slab has been poured, a formwork soffit is then erected. The next pre-cast construction element can then be lifted and inserted into position as described above, accurately fixed and plumbed, but leaving the space 46 clear for steel fixers to fix the reinforcement

required for the suspended floor below. The vertical pre-cast elements are free standing without the necessity of first pouring the concrete floor below. Therefore, preparation of the next level can commence whilst the floor on the previous level is being poured. It is envisaged that this construction method according to the present invention can reduce construction times by as much as 2-3 days per building level.

It will be appreciated that the oversized receiving tubes 60 will be dispensed with when the embodiment of the construction element 10 comprising the metal plates is used. Instead, with reference to FIG 11, metal plates extending substantially vertically from plate 56 will be welded in the appropriate position to which metal plates of the body 12 can be welded.

The positioning shoes 50 and collars 51 will now be described with reference to FIGS 12-15. FIGS 12 and 13 show the collar 51 attached to the receiving tube 36 of the element 10 below, which is already secured in position. The collar 51 is secured by a fastener in the form of a bolt and two nuts (not shown). A collar 51 is attached to each receiving tube 36 at each end of the pre-cast element 10. In the embodiment shown, slots 60 in the collar in the form of dovetailed rebates receive dovetailed protrusions 62 of positioning shoes 50. Once the upper element 10b is lowered into position as described above, winding bolts 64 can be adjusted to move screw plates 66 in contact with the body 12 and accurately position the upper element 10b as required until exactly the correct position for the element is achieved. FIG 14 shows an extended base 68 that abuts positioning shoe 50 and supports push-pull prop 54, which can pivot about pin 70 to adjust the angle of the prop 54. Once plates 24, 38

have been welded and/or the grout 34 has set, the temporary props 48, 54, shoes 50 and collars 51 can be removed.

An alternative embodiment of the positioning shoe 50 is shown in FIG 15. The positioning shoe 50 has a sloping face 72, which guides the upper, adjacent
5 element 10b into position when being lowered, for example, by a crane. In this embodiment, a nut 74 is cast into shoe 50 and a winding bolt 64 passes through the nut. Screw plate 66 is attached to the end of winding bolt 64 and is in contact with receiving tube 36 of lower element 10a. In an alternative
10 embodiment, screw plates 66 contact metal plates protruding from element 10. Hence, the shoe positions can be adjusted such that sloping faces 72 naturally guide the element accurately into position.

With reference to FIG 15A, according to one embodiment, supports 302 are attached to adjacent construction element 10b, for example, by means of bolts 304, such as Excaliber bolts. Supports 302 are attached to adjacent
15 construction element 10b in positions to support adjacent element 10b at the correct height above construction element 10a to create space 46 of the required height. Supports 302 support adjacent construction element 10b until coupling elements 14, 18 are welded together. Supports 302 may be in any suitable form to support the mass of the adjacent element 10b, which may range from, for
20 example, 1 tonne to 15 tonnes. Supports 302 may be formed from, for example, suitably thick steel plates welded at right angles with a bracing member.

Referring to FIGS 16-17, the pre-cast construction elements 10 can easily be moved around a building site and lowered into position using a conventional crane. This is achieved by means of lifting plates 76 that are bolted to the

element with washers through conduits 32 in body 12. A D clip 78 is bolted to each pair of lifting plates 78 such that the D clip can freely rotate when lifted via a crane sling 80. Hence, when the element 10 is lifted via the two D clips, the element naturally hangs vertically to facilitate easy positioning of the element 10.

5 This method of lifting overcomes the prior art problems associated with lifting pre-cast elements using clutches. Bolts pass through the full thickness of the construction element 10 via conduit 32, thus obviating the need for clutches and their associated risks. However, clutches may still be employed if required.

FIGS 18 and 19 show a plurality of construction elements 10a, 10b, 10c
10 connected together in accordance with the method described above and a plurality of poured floors 82 occupying the space between the coupled elements. For each level, a working platform 84 is bolted and plumbed to each construction element via existing conduits 32 in the elements 10 using Z bars or high tension (HT) bolts 86 or other suitable known fastening means. A tubular spacer 88 is
15 placed between the element 10 and a wall or plumbing mast 90 of the platform 84. Plumbing mast 90 includes a lifting lug 91 to enable a crane to lift the mast 90 in position. It will be appreciated that element 10 will comprise a conduit 92 toward the bottom of the body 12 as well as the conduit 32 toward the top of the body. Plumbing jacks 94 are set in the correct position prior to the next pre-cast
20 element being lifted into place and an adjustable edge form 96 remains in position until the concrete floor 82 is poured. A safety mesh 98 is provided on the outside of each platform 84 for protection whilst working. Once a platform 84 is in position at one level, the construction element 10 for the next level above can be safely lowered into place. Once positioned, bolts 86 attach the newly

positioned element to the plumbing mast 90. In addition to providing a safe working platform for shear walls at any height, platforms 84 provide easy access to the plates 14, 24, 38 for welding purposes, a straightforward means of providing adjustable edge form 96 and an accurate plumbing procedure for joining the elements 10 together.

FIGS 20 and 21 respectively show a lift core according to one embodiment and a stair core according to one embodiment constructed from the pre-cast construction elements 10 of the present invention. Some of the elements are cast with the end walls 100 returned to a minimum of, for example, 300mm, but preferably to the edge of doorways for easy joining above door heads. As shown in FIG 23, the elements 10 are cast with pre-welded reinforcing steel rods or steel plate 102. A plate 104 protrudes from the ends of the elements 10 by, for example, 40mm. The elements are erected as described above by coupling the coupling members 14 on an edge of one element with the coupling members 18 at an opposed edge of an adjacent element.

With reference to FIG 22, the protruding plates 104 overlap and are stitch welded together. Once welded, aluminium beams 106 are bolted either side of the gap 108 between the elements and non-shrink, liquid grout is poured in from the top to fill the gap 108 between the elements.

Alternatively, with reference to FIG 24, starter bars 110 may protrude from the precast elements 10, which are tied together between adjacent elements 10. Conventional formwork 112 may then be employed and concrete poured into the formwork to fill the gap 108 and form an element 10d conventionally.

The elements used for stair and lift cores shown in FIGS 20-24 employ a similar method of construction to that shown in FIGS 18 and 19, except that the safety platforms 84 are constructed on the inside rather than on the outside, as shown in FIGS 25 and 26. FIGS 25 and 26 show two methods of a wall and stair construction procedure according to an embodiment of the present invention. FIGS 25 and 26 each show two poured concrete floors 82 either side of a stair well formed from the elements 10 of the present invention. Plumbing masts 90 are provided on the inside and are bolted to the elements 10 until the grout 34 has matured. Adjustable slab edge formwork 114 is attached to the mast 90. Platform 84 provides a safe platform from which adjacent elements can be joined together. Access is also provided to a secondary platform 116 below to enable a worker to make good the elements below, for example, by sealing the conduits 32 in the elements 10. A safety scaffold 118 may also be provided.

FIG 26 shows the aforementioned alternative method of using conventional formwork 112 to cast an element 10d in situ with the precast elements of the present invention. The formwork 112 is provided on rolling platforms 120 for easy erection and stripping.

FIG 25A shows a plan view of a method of coupling adjacent construction elements 10 at the corner regions. Edges 16 and opposed edges 20 of the elements 10 comprise u-shaped bars 240 protruding from the body 12. U-shaped bars 240 overlap as shown in FIG 25A and reinforcing members 300 are passed through the u-shaped bars 240. Metal formwork 310 is provided at each corner attached to elements 10 with fasteners 312, such as Excaliber bolts.

Settable material, such as concrete, is then poured in the gap 316 to seal the construction elements 10 together.

With reference to FIGS 27 and 28, the method of joining horizontal pre-cast floor elements 10e according to two embodiments of the present invention will now be described. Precast floor elements 10e are poured in a conventional precast horizontal mould and in one embodiment have a finished thickness of about 80mm. The elements 10e comprise a rebate 180 at the edge to expose reinforcing members 22 and an inclined edge 182. Clutches are cast to the surface of the elements with emphasis on a centre clutch to prevent cracking of the element during lifting. The elements are rough surface finished with a vibrator and rough broom finished to prevent cracks whilst maintaining a rough surface.

On site, the precast elements 10e are supported on bearers 184 of conventional soffit formwork 186 such that inclined edges 182 of adjacent elements abut. For fire rating purposes, dry mix, non-shrink grout 188 fills the void 189 between the inclined edges 182. A flat steel plate 190 is welded via stitch welds 191 to the exposed reinforcing members 22 of adjacent elements creating a continuous bond between the reinforcing members 22 of adjacent elements. Reinforcing steel (not shown) is placed over the elements and the slab topping 192 can then be poured.

FIG 28 shows an alternative embodiment to that of FIG 27. In this embodiment, a steel plate 194 is welded to the reinforcing members 22 of each element 10e, for example, before the element is transported to the site. Flat steel plate 190 is welded via stitch welds 191 to steel plates 194 of adjacent

elements and the reinforcing steel and slab topping 192 are then added as described above.

The method of joining supported vertical pre-cast wall elements 10f according to an embodiment of the present invention will now be described with reference to FIGS 28A and 28B. In one embodiment, the pre-cast wall elements 10f have reinforcing members 22 running substantially parallel with a face of the body 12 in the locations shown, some of which are exposed by rebate 180. The elements 10f also comprise inclined edges 182 and, in one embodiment, a finished thickness of about 160mm. A steel plate 196 comprising a bolt 198 is welded via stitch welds 191 to reinforcing members 22 of adjacent elements 10f and the void 189 is filled with grout 188. Since adjacent wall elements 10f do not abut, a temporary seal (not shown) is provided during grout filling. An edge board 200, which may be, for example, aluminium or ply, spans adjacent elements and is fixed by means of the bolt 198 and a nut 201. The gap 202 is then filled with settable material, such as concrete, and the board 200 removed once the settable material in gap 202 has set. Alternatively, a conventional formwork element bolted between adjacent elements may be used.

A pre-cast construction element in accordance with an alternative embodiment of the invention is shown in FIGS 29-31. A pre-cast construction element 10 is provided comprising a body 12, at least one coupling member 14 protruding from an edge 16 of the body and at least one coupling member 14 provided at an opposed edge 20 of the body 12. In this embodiment, coupling members 14 are in the form of the ends of at least one I-beam 140 embedded in the body 12. In this embodiment, the at least one I-beam passes through the

length of the body 12. In the embodiment shown in FIG 29, two I-beams 140 extend through the length of the body extending between edge 16 and opposed edge 20. A metal bearing plate 142 is welded to the end of each I-beam 140 at one end of the element 10. In one embodiment, reinforcing (not shown) known
5 in the art, is included in the body 12 to ensure the required fire protection rating around the I-beams is provided. The elements may be cast in steel moulds and the concrete forming the body is poured vertically using, for example, a 10mm aggregate mix to ensure easy flow.

Two construction elements 10a, 10b are coupled together by abutting the
10 I-beams 140 protruding from a bottom edge of upper element 10b with the plates 142 welded to the top of I-beams 140 protruding from the top edge of lower element 10a below. The elements 10a, 10b are lifted into place using D shackles 78 under plates 142, as shown in FIG 31, or by attaching lifting lugs to conduits 32 in the body 12 as described above. FIG 30 shows a similar
15 construction method to that shown in FIG 8, in that once the first, lower construction element 10a is in position, collars 51 are attached to the top of the protruding I-beam 140 and the positioning shoes 50 are attached to the collars 51, as described above. The upper, adjacent element 10b is lowered into place such that the bottoms of I-beams 140 abut plates 142 of the lower element 10a.
20 Positioning shoes 50 are then adjusted to accurately position the upper element 10b. Temporary props 48 plumb the upper pre-cast element 10b before the bottoms of I-beams 140 are welded to plates 142 to create a complete composite fixing. Hence, a continuous composite steel bond (also known as a continuous "development bar") from the top to the bottom of any building is

created. In this embodiment, a space 46 is created between the lower and upper, adjacent construction elements 10a, 10b to enable a concrete floor to be poured in the space 46 without delaying the construction of higher levels.

With reference to FIG 32, a modified embodiment of the pre-cast construction element 10 of the present invention can be used, for example, to achieve different shaped building exteriors in situations where it is not possible to use the required depth of receiving tube 30 according to the invention. As shown in FIG 32, at least one coupling member 14 of the element 10 is in the form of a reinforcing member 144 protruding from a first edge 16 of the element 10. In this embodiment, reinforcing members 144 are embedded in the body 12 and are in the form of lengths of reinforcing steel extending substantially the length of the body and substantially toward opposed edge 20. Also embedded in the body 12 and protruding from edge 16 (or bottom) of the element 10 are coupling members 14 in the form of legs 146. Legs 146 are in the form of lengths of steel with a plate 148 welded to the end thereof forming a base. Alternatively, legs 146 may be formed from lengths of I-beam.

In FIG 32, an opposed edge 20 of the element 10 comprises coupling members 18 in the form of sockets 18 as described in relation to the first embodiment of the construction element 10, including hollow, corrugated tubes 30, receiving tubes 36 and conduits 32. Pre-cast construction element 10 also comprises a substantially central channel 150 extending between edge 16 and opposed edge 20 of the body 12. The channel 150 may be, for example, box shaped or circular in cross section and its purpose is described below.

As shown in FIG 32, element 10 is positioned by fastening the legs 146 to

the reinforced concrete slab 152 via plates 148. This can be achieved, for example, using Dyna bolts. The top of the element is accurately plumbed using temporary props 48. Starter bars 154 protruding from the reinforced concrete slab 152 are tied to the protruding reinforcing elements 144 of the element 10.

5 Conventional formwork 156 then surrounds the base area of the element including the reinforcing elements 144, legs 146 and starter bars 154. Settable material, such as 10mm aggregate super flow concrete, is poured down channel 150 to encase the base volume of the element 10. Once matured, the formwork 156 and props 48 are removed leaving the element 10 in position to commence
10 construction using the elements of the present invention as described above.

FIGS 33-35 show an alternative method of positioning a pre-cast construction element 10 above a floor 82 that has already been poured. In this embodiment, the receiving tubes 36 of the element 10 are used to locate positioning pins 158 to hold a rebate plate 160 in place. Rebate plate 160
15 reserves a recessed area on the floor 82 that is filled with non-shrink grout when the plate 160 is removed. A pre-cast element according to the invention can then be lowered into position from above such that rods 14 are inserted into receiving tubes 36 as described above.

FIG 36 shows an alternative pre-cast construction element in accordance
20 with another embodiment of the invention where the element 10 is larger than the standard column or wall elements 10. The element 10 shown comprises eight coupling members in the form of sockets 18 and eight associated coupling members in the form of receiving tubes 36 reinforced with welded plates 162. A structure formed from these interlocked larger elements therefore has the

necessary structural integrity by virtue of the increased number of interlocking coupling members and sockets.

With reference to FIGS 37-39, according to one embodiment, adjustable bolts 164 are provided in the pre-cast element 10, which are coupled to a member 166 cast into the element. Bolts 164 and member 166 enable the lateral and transverse position of the element to be corrected if required by adjustment of the appropriate bolts. This allows for fine-tuning of the positions of the elements to ensure accuracy.

With reference to FIGS 40-43, moulding of the pre-cast construction elements 10 of the present invention can be done horizontally or vertically. FIG 41 shows the alternative method of creating conduits 32 by inserting a bolt through a nut or washer or the like fixed to the end of the hollow tube 30 in the pre-cast construction elements. FIG 42 shows a mould 168 for vertically moulding the pre-cast construction elements in which forms 170 of the mould are bolted together at each end to prevent bleeding of the settable material during the pour. Z bars 86 are bolted through the forms to hold tubes 30 accurately in position and help prevent the forms 170 from moving during the pour. In this embodiment, a 5mm plate 173 comprises apertures 175, which have been accurately cut in the required positions using laser-cutting techniques to accommodate and accurately position rods 14. A plywood sheet 177 also helps support the rods 14 and helps prevent bleed from the mould 168. FIG 43 shows isometrically a typical vertically cast construction element according to an embodiment of the invention, including the coupling members 14 in the form of rods, sockets 18 in the form of tubes 30 and conduits 32 through which Z bars

86 pass to hold the tubes 30 in place during the casting pour sequence. The forms 170 are hinged via hinge means 171 at the corners to facilitate release of the forms and steel spacers 172 help maintain the correct position during the pour.

5 Another alternative embodiment of the pre-cast construction element 10 according to one aspect of the present invention is shown in FIGS 44 and 45. In this embodiment of the element 10, coupling members in the form of two sockets 18 are provided on edge 16 of the body 12 and coupling members 14 protrude from opposed edge 20 of the body. The sockets 18 are provided in the form of
10 hollow tubes 30 and coupling members 14 are in the form of steel rods 14, which are embedded in the body 12 to a depth that is greater than the length of rod 14 protruding from the body.

 The securing means 24, in the form of metal bearing plates 24 having an aperture 26 through which rod 14 can pass, are provided on edge 16 of the body
15 12. Plates 24 are secured to edge 16 of the body with the aid of rods or bars 28 that are welded to the plates and are embedded in the body 12. Hence, in contrast with the embodiment shown in FIG 1, metal bearing plates 24 are positioned over sockets 18 such that apertures 26 are aligned with the sockets 18.

20 On opposed edge 20 of the body, receiving tubes 36 are partially embedded in body 12 and partially protruding from opposed edge 20. However, in contrast with the embodiment shown in FIG 1, tubes 36 are welded to rods 14. Further detail of this arrangement is shown in FIG 45.

 Transverse conduits 32 are provided in this embodiment toward the end

of rods 14 for the same purposes as described above. However, this embodiment also comprises conduits 230 extending from the edges of body 12 to the sockets 18 to allow the pumping of grout into sockets 18 once adjacent elements 10 are in place.

5 Coupling of the elements 10 according to the embodiment shown in FIGS 44 and 45 will now be described. A lower element is secured in place with coupling members 14 on opposed edge 20 extending upwards. This is achieved as described above with reference to FIG 11, except that instead of oversized receiving tubes 60 being employed, coupling members 14 are used that are
10 inserted into the sockets 18 of the first, lower element.

 An upper, adjacent element is lowered such that the coupling members 14 of the lower element are inserted into and received by sockets 18 of the upper element until metal plates 24 on edge 16 of the upper, adjacent element abut bearing plates 38 of receiving tubes 36 of the lower element such that a
15 spaced relationship exists between the two pre-cast construction elements. In the correct position, a space 46 is created between the upper and lower elements for the pouring of a floor structure as described above. The upper and lower elements are secured and accurately positioned as described above using the positioning shoes 50, collars 51 and temporary props 48. Once the correct
20 position has been achieved, metal bearing plates 24 and bearing plates 38 are stitch welded. Non-shrink grout 34 is pumped into sockets 18 via conduits 230. Once the grout has set, positioning shoes 50, collars 51 and temporary props 48 are removed leaving a free-standing upper, adjacent pre-cast construction element.

A further alternative embodiment of the pre-cast construction element 10 according to one aspect of the present invention is shown in FIG 46. This embodiment is similar to that shown in FIG 44 in that coupling members in the form of sockets 18 are provided on edge 16 of the body 12 and coupling members 14 in the form of rods protrude from opposed edge 20 of the body. However, in this embodiment, hollow receiving tubes 36 are coupled to sockets 18 such that they are partially embedded in body 12. In this sense the socket and receiving tube arrangement resembles that in the embodiment shown in FIG 1. Metal plates 24 with apertures 26 through which rods 14 pass are provided on opposed side 20, as described in relation to FIG 1.

The method of construction using the embodiment shown in FIG 46 is as follows. Once a first, lower element is in position as described in relation to the embodiment in FIGS 44 and 45, adjacent upper element is lowered such that rods 14 of the lower element are inserted into receiving tubes 36 and sockets 18 of the upper, adjacent element. The upper element is lowered until bearing plates 38 of the upper element abut plates 24 of the lower element. The elements 10 are accurately positioned using the positioning shoes 50, collars 51 and temporary props 48 as described above and bearing plates 38 are stitch welded to abutting plates 24 of the adjacent element below. The receiving tubes 36 are positioned in the body 12 of element 10 such that a space 46 is created between the upper and lower elements for the pouring of a floor structure as described above. Non-shrink grout 34 is pumped into sockets 18 via conduits 230 extending between the edges of the body 12 and bases of the sockets 18.

Once the grout has set, positioning shoes 50, collars 51 and temporary props 48 are removed.

A yet further alternative embodiment of the pre-cast cementitious construction element 10 according to another aspect of the present invention is shown in FIGS 47 and 48. The element 10 is the same as the element shown in FIG 1, except that at least one substantially u-shaped bar 240 is partially embedded in the body 12 and protrudes from edge 16 and/or opposed edge 20 of the body 12. In the embodiment shown, a first pair of u-shaped bars 240a protrude from edge 16 of the body 12 and a second pair of u-shaped bars 240b protrude from opposed edge 20 of the body. First and second pairs of u-shaped bars 240a, 240b are tied to the reinforcing members 22 of the element by any suitable means known in the art.

With reference to the composite sectional view shown in FIG 48, which shows both top and bottom views of the body of FIG 47, the first pair of u-shaped bars 240a are located inwardly of the second pair of u-shaped bars 240b such that bars 240a are situated closer to a central axis 241 of the edges of the element 10 than bars 240b. In this embodiment, the u-shaped bars lie substantially parallel with the central axis 241.

When two elements 10 are coupled together, as described above, the first pair of u-shaped bars 240a lie between and substantially parallel with the second pair of u-shaped bars 240b of the adjacent element. The u-shaped bars 240 thus extend into the space 46 created between the elements 10. Consequently, the u-shaped bars 240 provide a complete "development bar" between the reinforcing members 22 of adjacent structural elements. The u-shaped bars 240

also provide additional reinforcement to the floor 82 poured in the space 46 between the coupled elements 10. The reinforcement used for the floors also ties the adjacent u-shaped bars 240a, 240b together. Improved structural integrity between the construction elements 10 and the floor 82 is thus achieved.

5 FIGS 49 and 50 show another embodiment of the pre-cast construction element 10 similar to the embodiment shown in FIGS 47 and 48. In this embodiment, a plurality of u-shaped bars 240 are embedded in the body 10 such that a plurality of first u-shaped bars 240a protrude from edge 16 and a plurality of second u-shaped bars 240b protrude from opposed edge 20. As shown in
10 FIG 50, the positions of the first and second u-shaped bars are offset with respect to each other such that one set of u-shaped bars pass between the other set.

 It will be appreciated that the concept achieved by the u-shaped bars 240 could be achieved with a single u-shaped bar protruding from edge 16 and a
15 single u-shaped bar protruding from opposed edge 20, the bars being positioned relative to the central axis 241 such that when adjacent elements 10 are coupled together, the bars do not collide. It will also be appreciated that in an alternative embodiment, the u-shaped bars 240b protruding from the second edge 20 may lie closer to the central axis 241 than the u-shaped bars 240a protruding from
20 edge 16. Other variations in the shape and positioning of the u-shaped bars 240 are also envisaged. For example, alternatively, the u-shaped bars 240 may be rotated through 90 degrees such that they lie substantially perpendicular to the central axis 241. Such an orientation of the u-bars 240 may better facilitate the running of reinforcement through the u-shaped bars and the structure.

FIG 51 shows an alternative embodiment of the lifting apparatus to that shown in FIG 16. The features of the body 12 and lifting apparatus are the same as those shown in FIG 16 and described above, except that lifting clutches 242 are embedded in the body 12 of the element 10 during the pre-cast process to which safety chains 244 are attached during lifting. As described above, the safety chains 244 are not essential for lifting, but provide backup support in the unlikely event that there is a failure in the lifting plates 76, D-clips 78 and/or crane sling 80. However, unlike with the prior art, because the safety chains 244 are a secondary lifting means, they do not need to pass all the way around the element 10, which is time consuming to do and can cause damage to the cementitious body 12. Instead, the safety chains 244 can easily be attached to the lifting clutches 242. The safety chains may also be required to satisfy work health and safety requirements in some countries/states/regions.

FIG 52 shows another embodiment of the receiving tube 36 in which a square shaped steel washer 44 is welded to bottom plate 40 through which a bolts passes during casting of the element and which is used to aid positioning of the element. FIG 53 shows another view of the receiving tube 36, corrugated tube 30, transverse conduit 32 and non-shrink grout 34.

Hence, the pre-cast cementitious construction elements, methods and systems of construction of the present invention thus provide solutions to the aforementioned problems of the prior art by virtue of the accurately located coupling members 14, 18 of the construction elements 10 that enable the elements to be easily and accurately positioned. Accurate positioning is further facilitated by the positioning shoes 50 and collar 51. The welding of the coupling

elements of adjacent elements ensures adjacent elements are secured in the correct position. The space 46 created between adjacent elements enables floor structures 82 to be poured as required without delaying the construction of higher structures or preparatory formwork. The space 46 also facilitates the provision of a complete "development bar" throughout the structure with reinforcing members. Transverse conduits 32 in the elements facilitate the building process since working platforms 84 may be attached thereby both internally and externally and the elements 10 may be lifted safely via the conduits 32. Props 48, 54 are only required to support the construction elements temporarily until the coupling members are welded together. Once welded, the props can be removed to leave a free-standing pre-cast cementitious construction element upon which the next level can be constructed. The strength and structural integrity of the elements and the structure composed of such elements enables smaller volumes of material to be used, which reduces material costs and increases the internal space available. Further benefits and advantages of the construction elements of the present invention will be readily apparent from the foregoing detailed description.

Throughout the specification the aim has been to describe the invention without limiting the invention to any one embodiment or specific collection of features. Persons skilled in the relevant art may realize variations from the specific embodiments that will nonetheless fall within the scope of the invention.

CLAIMS:

1. A pre-cast cementitious construction element comprising:
a body;
at least one coupling member protruding from an edge of the body; and,
5 at least one coupling member provided at an opposed edge of the body,
said at least one coupling member protruding from an edge being adapted
to couple with a coupling member at an opposed edge of an adjacent pre-
cast construction element such that, when coupled, a spaced relationship
exists between said pre-cast construction element and said adjacent pre-
10 cast construction element.
2. The construction element of claim 1, wherein the coupling members are
metal plates extending from the edge and the opposed edge of the body.
- 15 3. The construction element of claim 2, wherein the metal plates are partially
embedded in the body.
4. The construction element of claim 2, further comprising reinforcing
members welded to the metal plates.
- 20 5. The construction element of claim 4, wherein the reinforcing members are
completely embedded in the body.
6. The construction element of claim 4, wherein the reinforcing members are

u-shaped.

7. The construction element of claim 1, wherein the at least one coupling member protruding from an edge of the body is a rod.

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8. The construction element of claim 7, wherein the rod is at least partially embedded in the body.

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9. The construction element of claim 7, further comprising a bearing plate provided around said rod at the edge of the body.

10. The construction element of claim 1, wherein the at least one coupling member provided at an opposed edge of the body comprises a socket extending into the body.

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11. The construction element of claim 10, wherein the socket comprises a hollow tube embedded in the body.

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12. The construction element of claim 10, wherein the at least one coupling member provided at an opposed edge of the body further comprises a hollow receiving tube at least partially embedded in the body.

13. The construction element of claim 12, wherein a longitudinal axis of the hollow receiving tube is aligned with a longitudinal axis of the socket.

14. The construction element of claim 12, further comprising a bearing plate provided on a free end of the hollow receiving tube, said bearing plate having an aperture therethrough.

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15. The construction element of claim 10, further comprising a conduit extending between opposed faces of the body through each said socket.

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16. The construction element of claim 10, further comprising a bearing plate provided at the opposed edge of the body around an aperture of said socket.

15

17. The construction element of claim 7, wherein the at least one coupling member protruding from an edge of the body further comprises a hollow receiving tube at least partially embedded in the body.

18. The construction element of claim 17, wherein a longitudinal axis of the hollow receiving tube is aligned with a longitudinal axis of the rod.

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19. The construction element of claim 7, further comprising a conduit extending between opposed faces of the body at the base of each said rod.

20. The construction element of claim 7, further comprising at least one conduit extending between a base of said socket and an edge of the body.

21. The construction element of claim 1, wherein the coupling members are I-beams.

5 22. The construction element of claim 21, wherein the at least one coupling member protruding from an edge of the body and the at least one coupling member provided at an opposed edge of the body is an I-beam embedded in the body, said I-beam extending between an edge of the body and an opposed edge of the body.

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23. The construction element of claim 21, further comprising a bearing plate provided on an end of each said I-beam.

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24. The construction element of claim 1, further comprising a channel extending between an edge of the body and an opposed edge of the body.

25. The construction element of claim 1, wherein the at least one coupling member protruding from an edge of the body comprises at least one reinforcing member.

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26. The construction element of claim 25, wherein the at least one reinforcing member is embedded in said body and extends substantially toward an opposed edge of the body.

27. The construction element of claim 1, further comprising at least one substantially u-shaped bar protruding from an edge of the body.
28. The construction element of claim 1, further comprising at least one
5 substantially u-shaped bar protruding from an opposed edge of the body.
29. The construction element of claim 28, wherein, when said pre-cast construction element is coupled to said adjacent pre-cast construction element, the at least one substantially u-shaped bar protruding from an
10 opposed edge of the body of said pre-cast construction element is substantially aligned with at least one substantially u-shaped bar protruding from an edge of the body of said adjacent pre-cast construction element.
30. The construction element of claim 28 or 29, wherein the substantially u-
15 shaped bars are substantially aligned with a central axis of an edge and/or an opposed edge of the body.
31. The construction element of claim 28 or 29, wherein the substantially u-
20 shaped bars are substantially perpendicular to a central axis of an edge and/or an opposed edge of the body.
32. The construction element of claim 1, further comprising at least one adjustable bolt for adjusting a position of the construction element.

33. A method of construction using pre-cast cementitious construction elements, each said construction element comprising:

a body;

at least one coupling member protruding from an edge of the body;

5 and,

at least one coupling member provided at an opposed edge of the body, said at least one coupling member protruding from an edge being adapted to couple with a coupling member at an opposed edge of an adjacent pre-cast construction element;

10 said method including the step of coupling a pre-cast construction element to an adjacent pre-cast construction element such that a spaced relationship exists between said pre-cast construction element and said adjacent pre-cast construction element.

15 34. The method of claim 33, further including the step of constructing at least part of a floor structure in a space between said pre-cast construction element and said adjacent pre-cast construction element.

20 35. The method of claim 33, further including the step of supporting the adjacent pre-cast construction element with at least one prop.

36. The method of claim 33, wherein the coupling step includes welding together the at least one coupling member protruding from an edge of the body and the at least one coupling member provided at an opposed edge

of the body.

37. The method of claim 36, further including the step of removing at least one prop supporting the adjacent pre-cast construction element once the at least one coupling member protruding from an edge of the body and the at least one coupling member provided at an opposed edge of the body have been welded together to leave a free-standing adjacent pre-cast construction element.

38. The method of claim 33, wherein the coupling step includes inserting the at least one coupling member of said construction element into the at least one coupling member of said adjacent construction element.

39. The method of claim 33, wherein the coupling step includes inserting at least one rod of said construction element into a socket extending into the body of said adjacent construction element.

40. The method of claim 39, wherein the at least one rod is inserted until a bearing plate provided around said rod on said construction element abuts a hollow receiving tube aligned with said socket of an adjacent construction element.

41. The method of claim 39, wherein the at least one rod is inserted until a hollow receiving tube aligned with said rod on said construction element

abuts a bearing plate provided around said socket of an adjacent construction element.

42. The method of claim 33, wherein the coupling step includes abutting an end of at least one I-beam of said construction element with a bearing plate provided at an end of an I-beam of said adjacent construction element.

43. The method of claim 33, wherein the coupling step includes aligning at least one u-shaped bar protruding from an edge of the body of said construction element substantially parallel with at least one u-shaped bar protruding from an opposed edge of an adjacent construction element.

44. The method of claim 33, wherein the coupling step includes aligning a pair of u-shaped bars protruding from an edge of the body of said construction element substantially parallel with and between a pair of u-shaped bars protruding from an opposed edge of an adjacent construction element.

45. The method of claim 43, further including the step of running reinforcing members through said substantially aligned u-shaped bars.

46. The method of claim 39, further including the step of filling said socket with settable material.

47. The method of claim 33, further including the step of guiding the adjacent

construction element into position with the aid of at least one positioning shoe.

48. The method of claim 47, further including the step of affixing a collar to the coupling member protruding from an edge of the body and abutting said positioning shoe against said collar.

49. The method of claim 47, further including the step of temporarily supporting said adjacent construction element with a prop coupled to a base, said base abutting the positioning shoe.

50. The method of claim 33, further including the step of coupling a working platform to the construction element via a conduit in said construction element.

51. The method of claim 33, wherein the coupling step includes welding together the at least one coupling member protruding from an edge of the body and the at least one coupling member protruding from a foundation.

52. The method of claim 51, further including the step of filling a volume around the at least one coupling member protruding from an edge of the body and the at least one coupling member protruding from the foundation with settable material.

53. The method of claim 52, wherein the step of filling includes pouring settable material through a channel in the construction element, said channel extending from an edge of the construction element to an opposed edge thereof.

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54. A building system for a multi-storey construction comprising:
a plurality of pre-cast cementitious construction elements, each said construction element comprising:

a body,

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at least one coupling member protruding from an edge of the body;

and,

at least one coupling member provided at an opposed edge of the body, said at least one coupling member protruding from an edge

being adapted to couple with a coupling member at an opposed

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edge of an adjacent pre-cast construction element such that, when

coupled, a spaced relationship exists between said pre-cast

construction element and said adjacent pre-cast construction

element; and

a plurality of floor structures, each said floor structure extending through a

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space between one of said pre-cast construction elements and an adjacent pre-cast construction element.

55. A base for a pre-cast cementitious construction element as claimed in claim 1, said base comprising:

a plate supported by a foundation; and
at least one coupling member protruding from said plate, said at least one
coupling member adapted to couple with at least one coupling member
protruding from an edge of said construction element.

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56. A method of joining pre-cast cementitious construction elements as claimed
in claim 1, said method including the steps of:

welding together reinforcing members of a construction element and an
adjacent construction element; and

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filling a space between said constructions elements with settable material.

57. A structure comprising the pre-cast cementitious construction elements of
claim 1.

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