United States Patent [19]

Dawson et al.

[11] **3,775,928**

[45] **Dec. 4, 1973**

[54] **ERECTION METHOD FOR STRUCTURAL SYSTEM**

[75] Inventors: **William F. Dawson; Milo Shemie,** both of Montreal, Quebec, Canada

[73] Assignee: **Descon Concordia Systems, Ltd. c/o Sage, Gray, Todd & Sims,** New York, N.Y.

[22] Filed: **Mar. 9, 1972**

[21] Appl. No.: **233,043**

[52] **U.S. Cl.** **52/741,** 52/285, 52/432

[51] **Int. Cl.** **E04b 1/35**

[58] **Field of Search** 52/175, 285, 432, 52/741, 167, 747

[56] **References Cited**

UNITED STATES PATENTS

3,136,092	6/1964	Contini	52/175
2,920,475	1/1960	Graham	52/432
3,372,519	3/1968	Russell	52/285

FOREIGN PATENTS OR APPLICATIONS

6,715,813	10/1968	Netherlands	52/285
1,157,689	12/1957	France	52/285

Primary Examiner—Price C. Faw, Jr.
Attorney—Myron Cohen et al.

[57] **ABSTRACT**

A structural system includes a building unit comprising at least a pair of spaced apart concrete wall slabs which support a concrete floor slab thereon which is connected directly to the wall slabs by the use of bolting means and tie plates embedded in the wall and floor slabs. The end portions of the floor slab have recesses therein which have tie plates extending across at least a portion thereof. The top portions of the wall slabs have tie plates protruding therefrom. The wall and floor slab tie plates have apertures therein which are aligned to form through holes, the bolting means being connected through these through holes to form a self-supporting building unit. Adjacent building units in the structure share a common wall slab and the adjacent end portions of adjacent floor slabs associated therewith are directly connected to each other and to the common wall slab by aligning the apertures in the associated tie plates to form through holes, bolting means being connected therethrough. A plurality of floor slabs may be supported between a pair of common wall slabs with the end portions of the floor slabs connected thereto as above. Adjacent side portions of adjacent floor slabs have recesses therein which are in communication and which have flat plates having apertures therein extending thereacross. These adjacent side portions are connected to each other by connector plates having apertures therein which are aligned with the apertures in the flat plates to form through holes, a bolting means being connected therethrough. Concrete wall slabs normal to the floor supporting wall slabs may also be provided, such as along the longitudinal axis of the structure, to vertically transfer laterally applied loads such as shear transmitted across the floor slabs which are ultimately connected thereto. In constructing a structure, supporting wall slabs are anchored to the wall or foundation below by bolting, floor slabs are placed thereon and aligned and adjacent side portions thereof directly connected together by bolting, and thereafter end portions thereof are directly connected to the supporting wall slabs by bolting.

9 Claims, 18 Drawing Figures

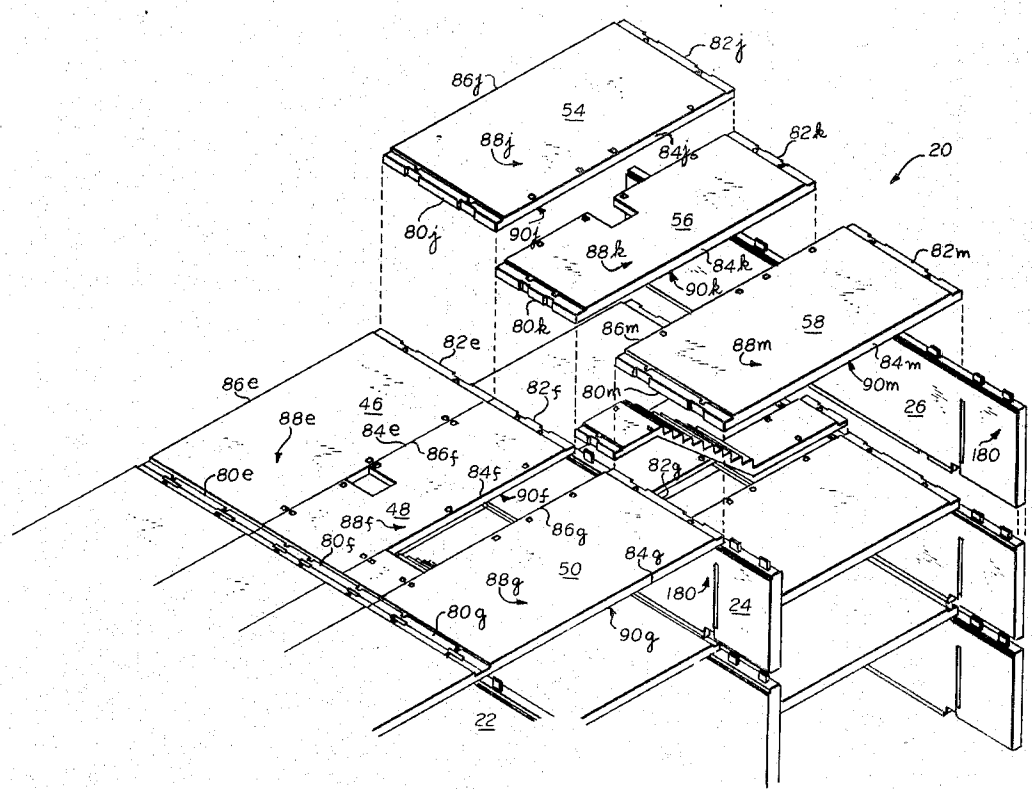


FIG. 1.

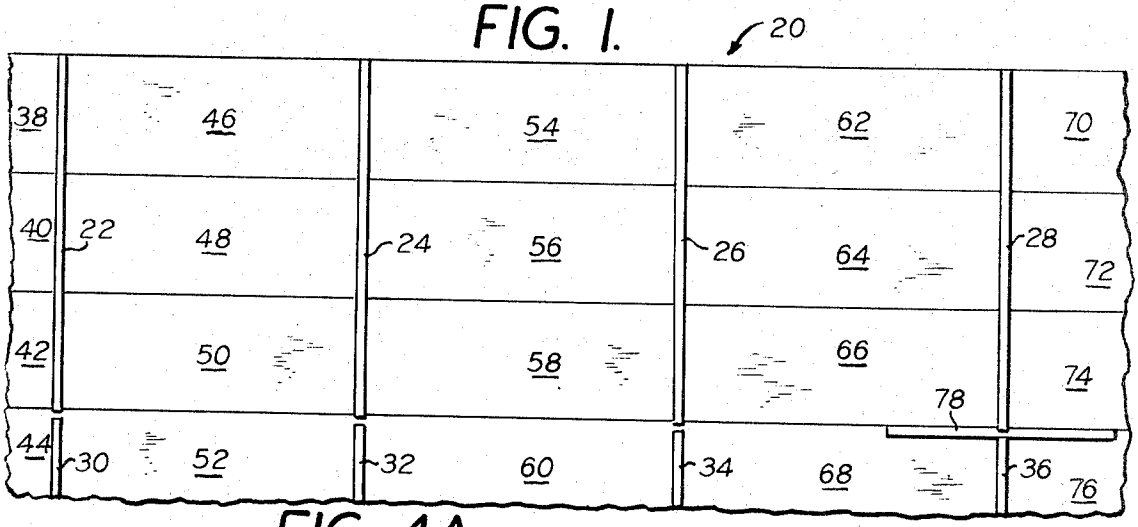


FIG. 4A.

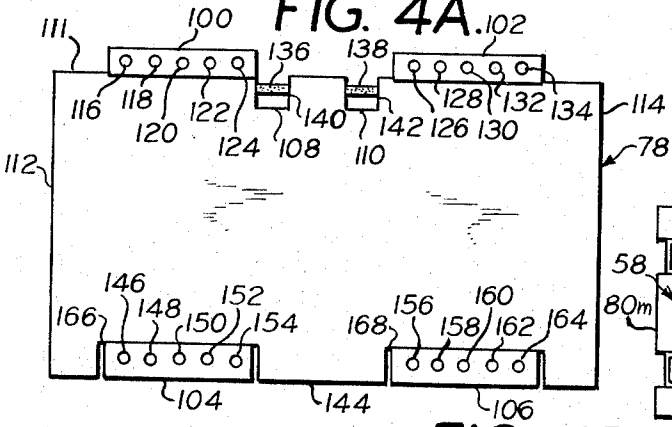


FIG. 6.

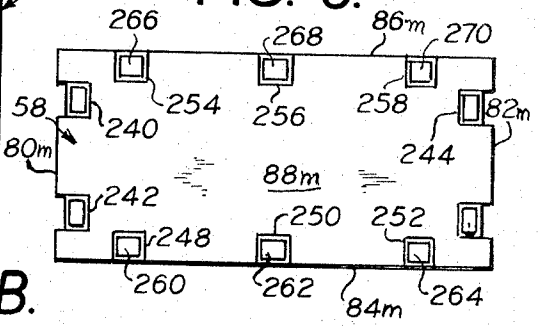


FIG. 4B.

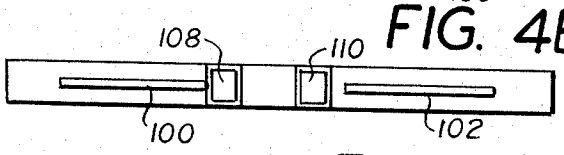


FIG. 5.

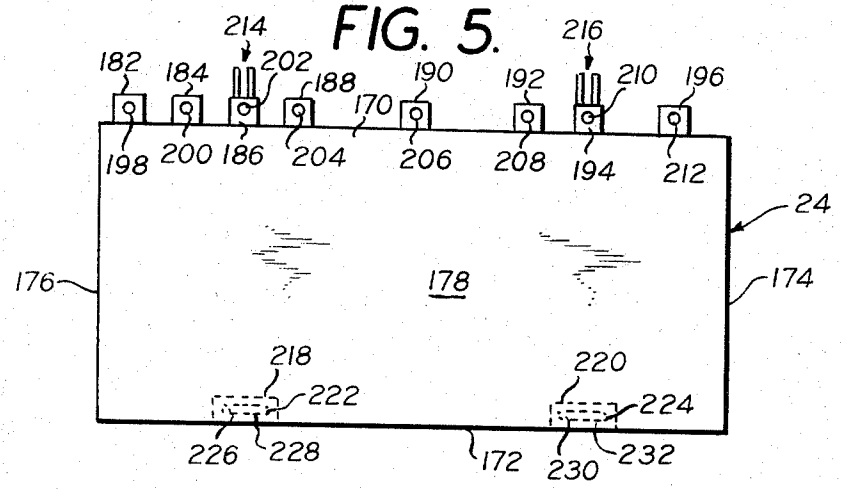
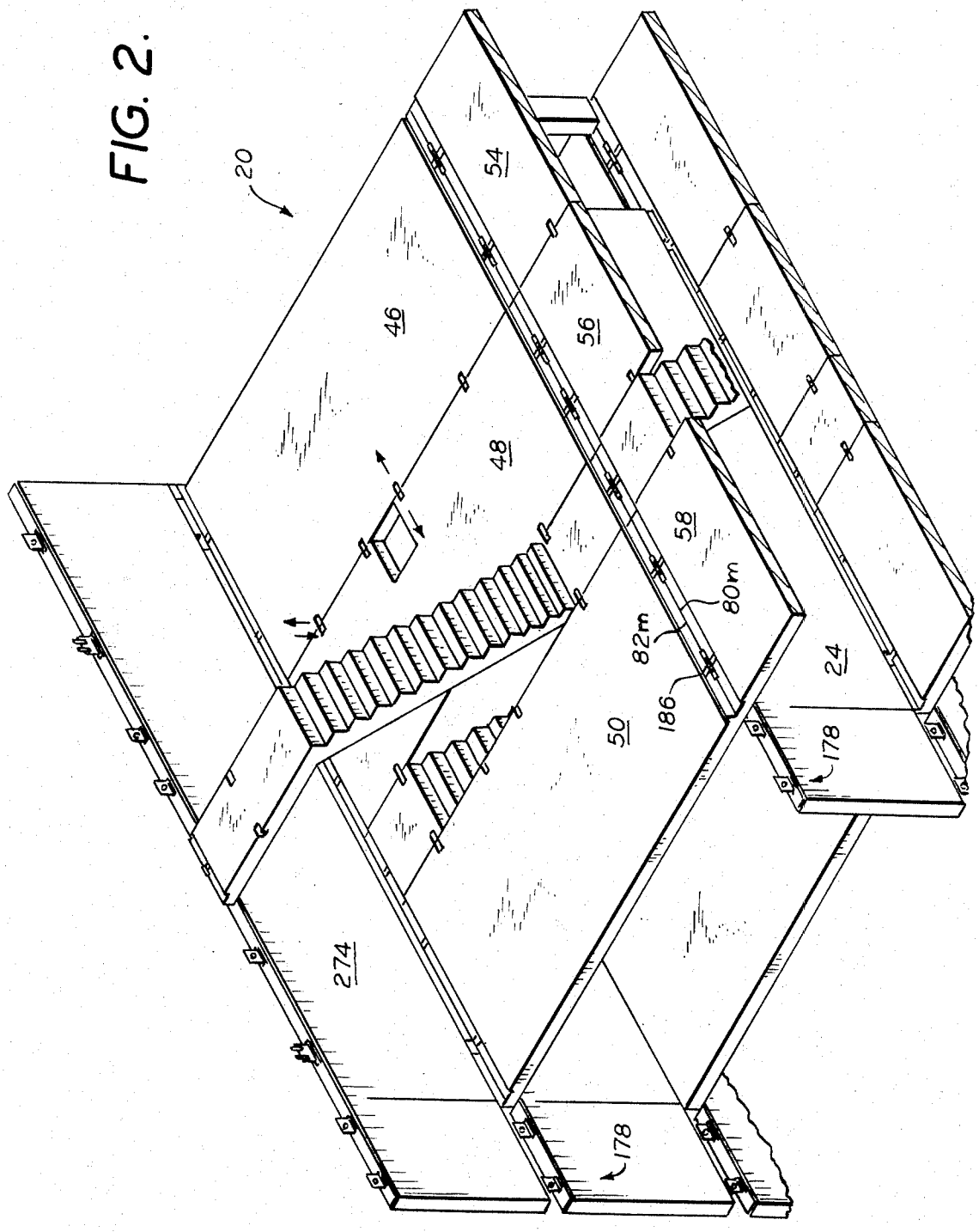


FIG. 2.



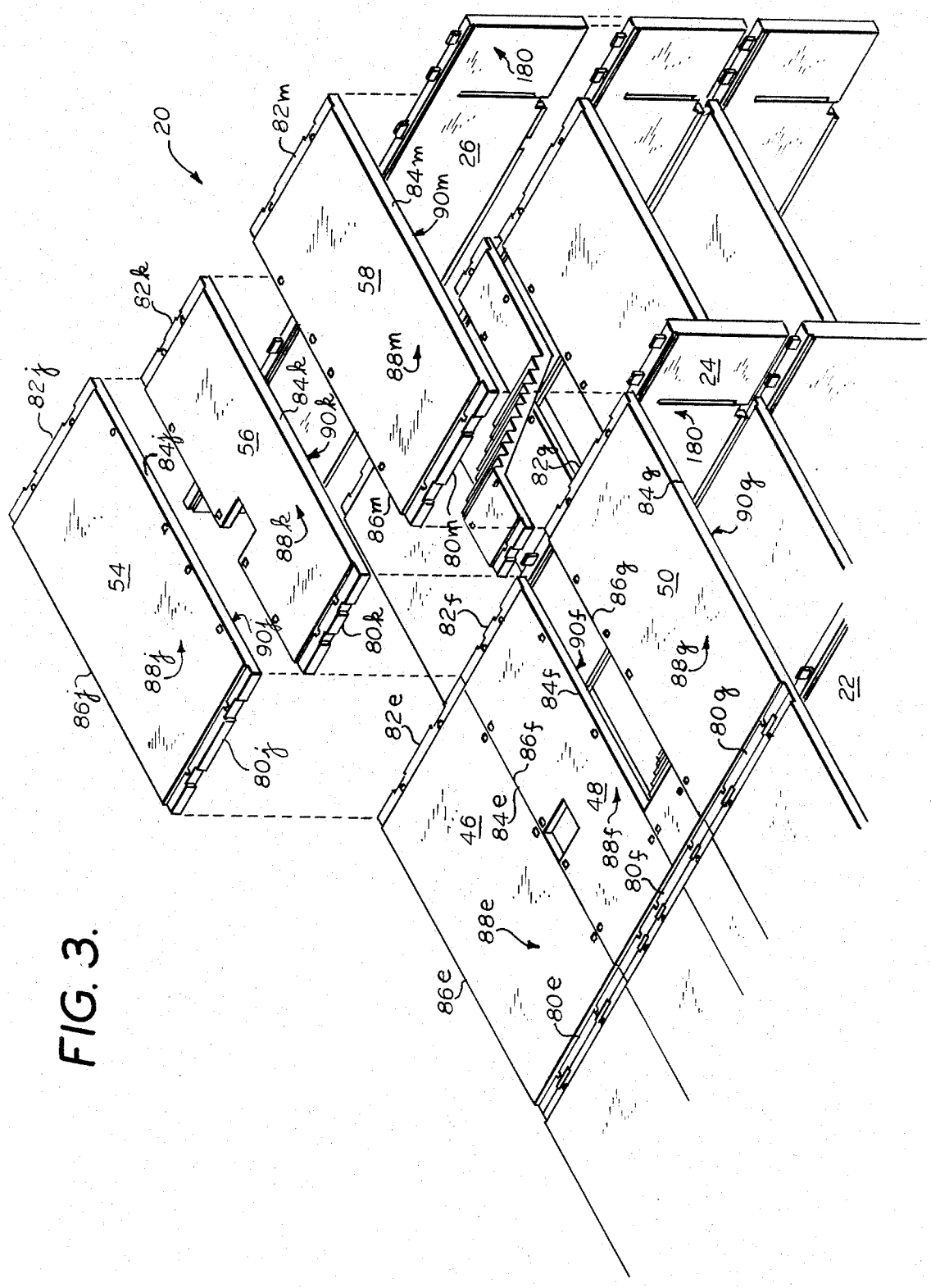

20
82m
84m
90m
26
180
58
82k
84k
90k
88m
82j
84j
56
88k
86m
80m
82g
84g
180
24
90g
54
88j
82f
86g
50
90f
88g
86j
84f
80g
22
80j
82e
86f
46
84e
48
88f
80f
88e
86e
80e

FIG. 3.

FIG. 7.

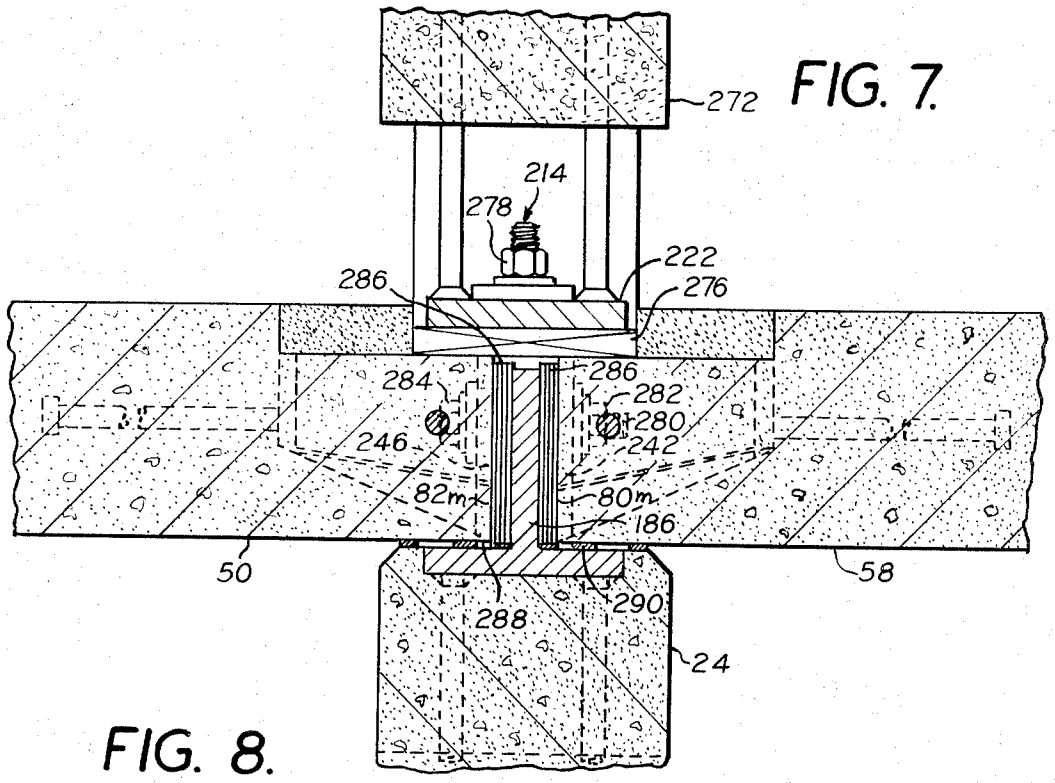

272
214
278
222
276
286
284
286
282
280
246
242
82m
80m
186
50
58
288
290
24

FIG. 8.

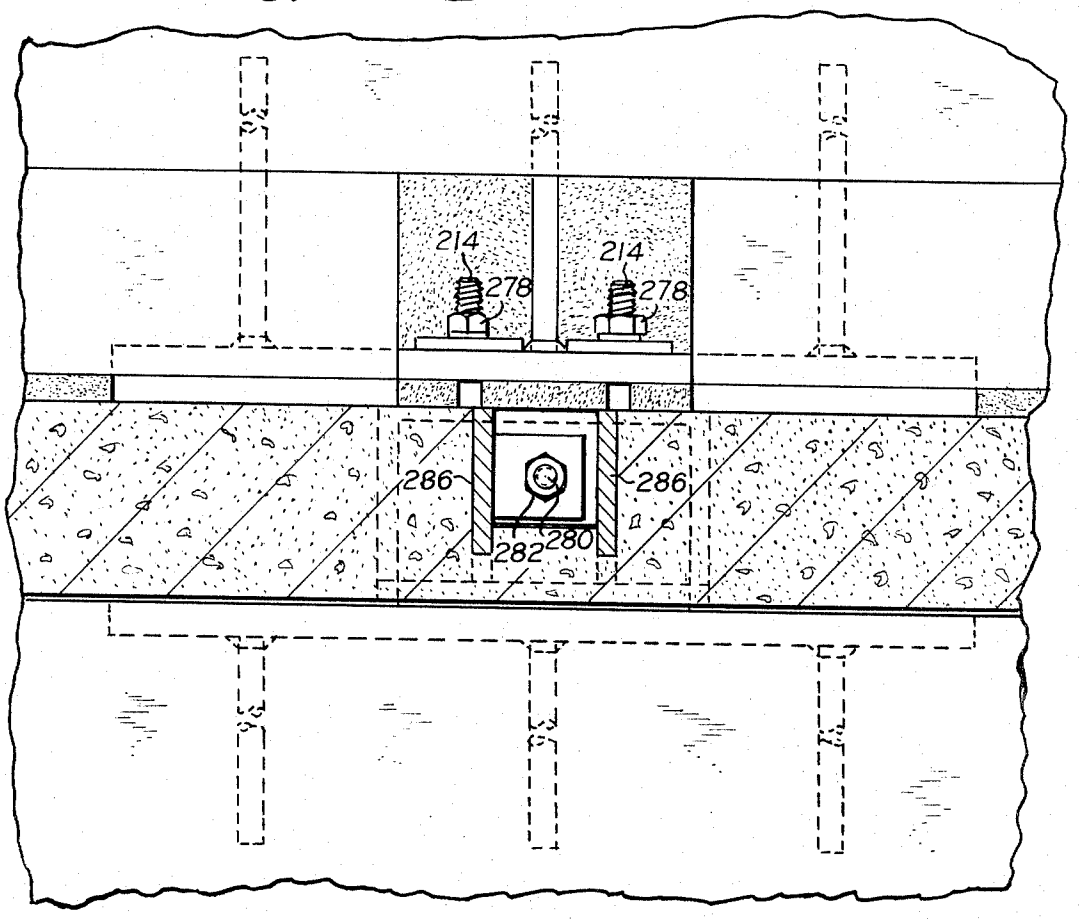

214
278
214
278
286
286
282
280

FIG. 9.

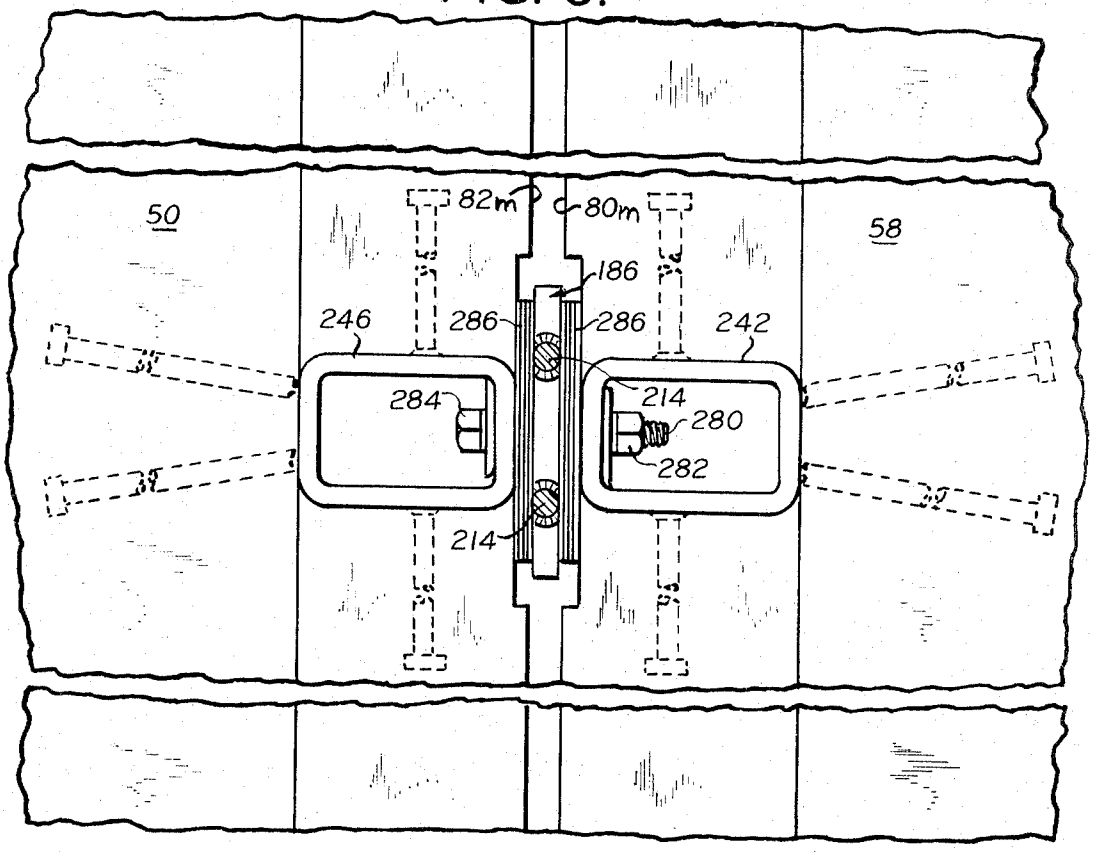

50
82m
80m
58
186
246
286
286
242
284
214
280
282
214

FIG. 10.

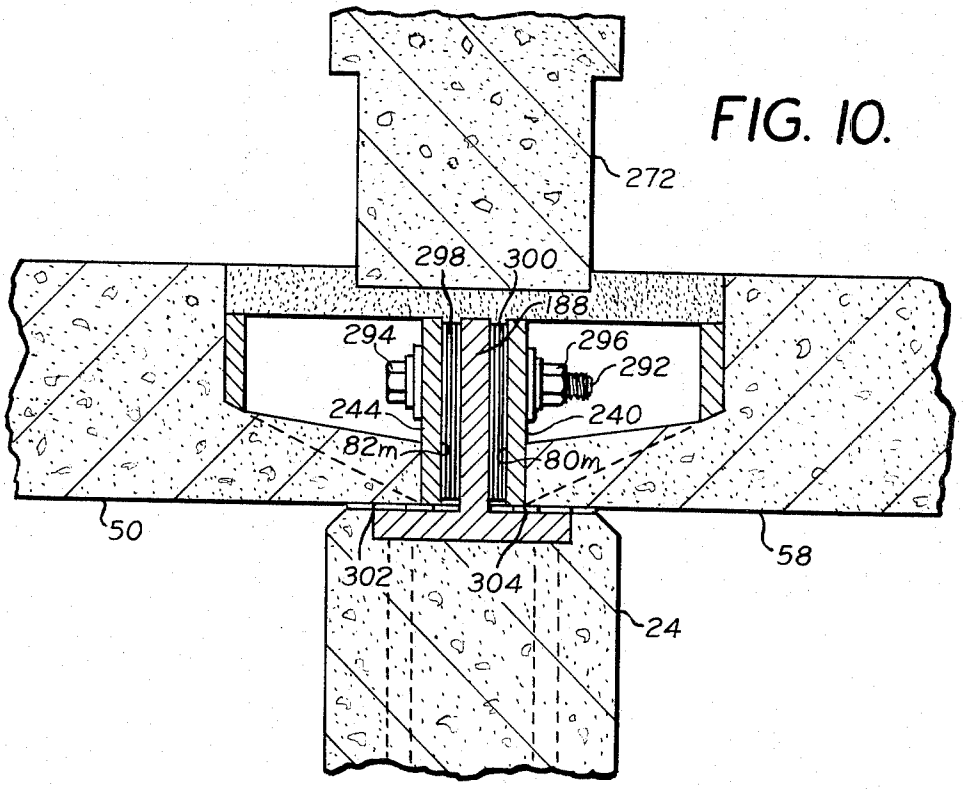

272
298
300
188
294
296
292
244
240
82m
80m
50
58
302
304
24

FIG. 11.

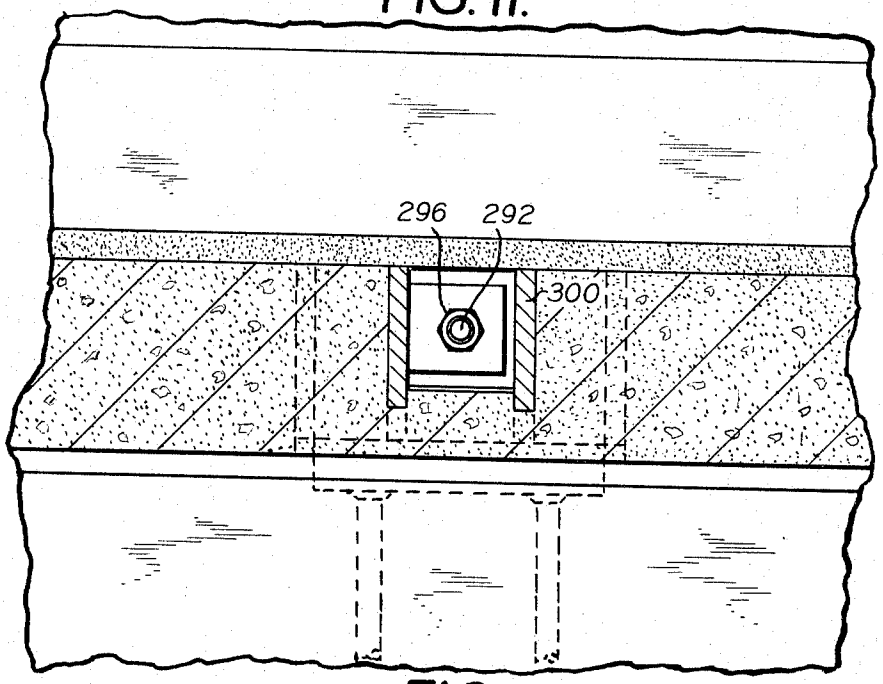


FIG. 12.

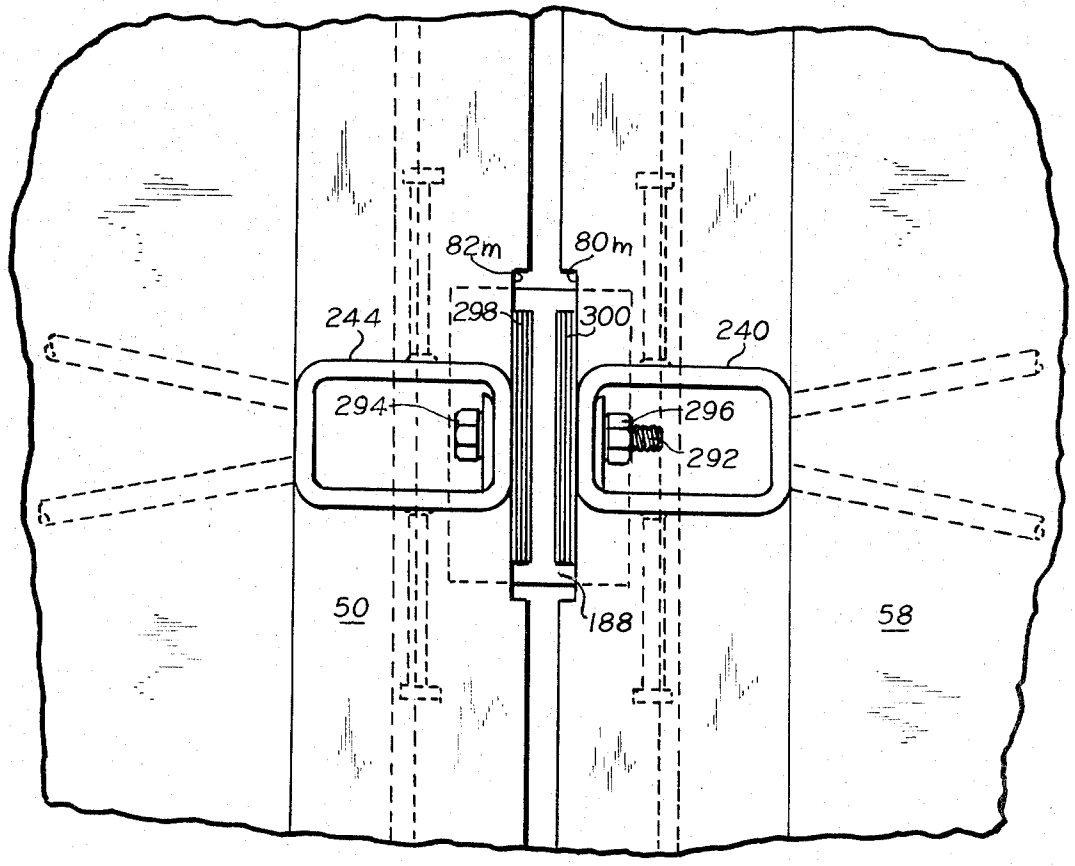


FIG. 13.

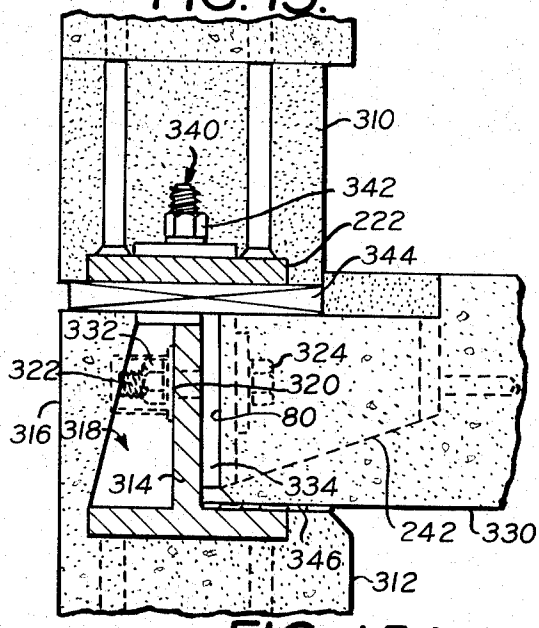


FIG. 14.

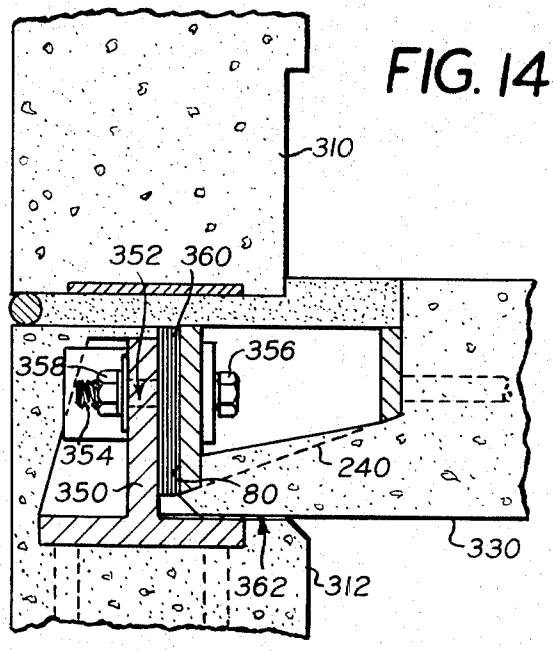


FIG. 15A.

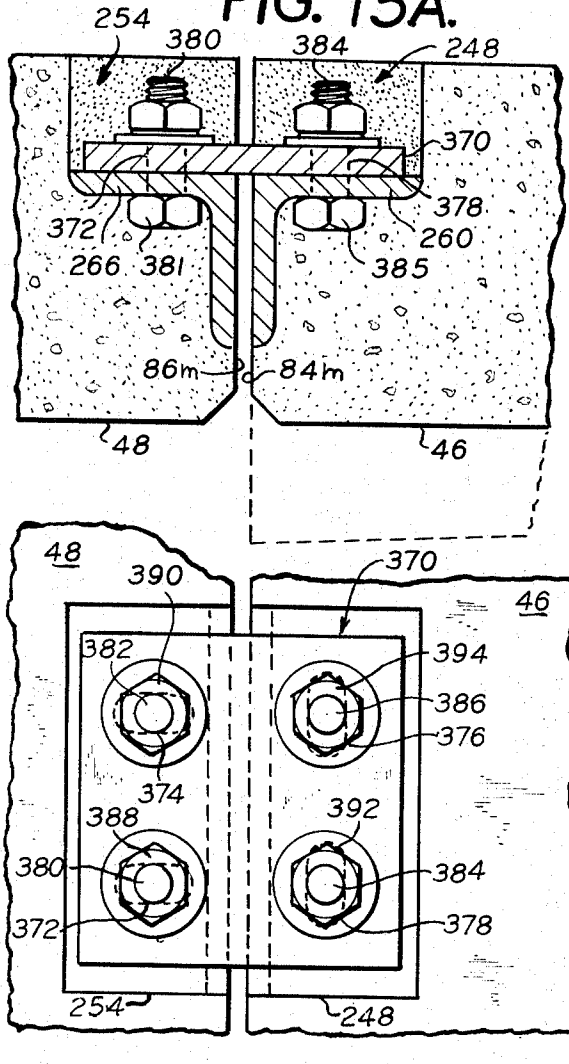


FIG. 16.

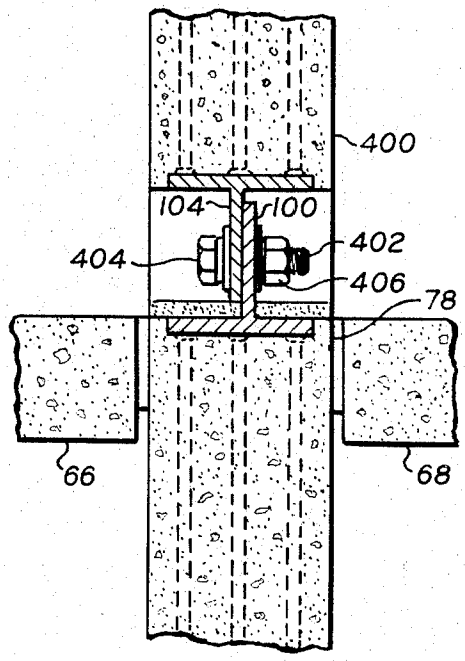


FIG. 15B.

ERECTION METHOD FOR STRUCTURAL SYSTEM

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to structural systems employing concrete slabs for both walls and floors in which the slabs are directly connected together.

2. Description of the Prior Art

Prior art concrete building structures normally involve the use of a superstructure which is a composite structure made up of precast concrete and structural steel. Such structures are subject to progressive collapse in the event of local explosion or local damage to the structure as well as being susceptible to earthquake damage even at the lowest readings on the Richter scale. Although the structure is a composite structure, the various columns, walls and floors making up the structure tend to act substantially independently when subjected to applied loads due to earthquakes or local explosions as these structures are normally incapable of distributing such applied loads throughout the structure. Furthermore, such structural systems normally require the use of grouting during the erection process as well as the use of welding and, thus, the erection process is quite time consuming to allow for these procedures. Furthermore, the use of welding and grouting requires the utilization of highly skilled craftsmen. In addition, since these structures require the use of grouting, such a structure may not be erected in all weather conditions resulting in the perennial construction problem of variations in environmental conditions affecting the amount of time required to complete a building structure. This highly seasonal restriction on construction is unsatisfactory.

As was previously mentioned, such prior art structures do not have sufficient resistance to wind and earthquake loads as their resistance to cumulative shear and overturning moments is unsatisfactory. In order to attempt to compensate for such low resistance, structures of this type must be considerably reinforced, particularly in high probability earthquake areas, at a considerably higher cost than the normal cost of construction of such a structure. As was also previously mentioned, such prior art structures are susceptible to progressive collapse. Furthermore, such prior art structures require the use of a multiplicity of building elements such as beams, columns, etc., as well as walls and floors, increasing both the time and cost of construction and minimizing the possibility of the material manufacturing process associated therewith being repetitive.

The inability of these prior art concrete structures to sufficiently resist both earthquake loads as well as local explosions and progressive collapse has resulted in time consuming and costly construction procedures such as the requirement of the use of temporary supporting frames during construction until the grout utilized with the associated joints has set. Thus, these prior art systems which require the pouring in place, during erection, of a concrete grout to insure continuity and, incidentally, to prevent progressive collapse are not satisfactory, nor are such systems which require welded connections to obtain continuity.

These disadvantages of the prior art are overcome by the present invention.

SUMMARY OF THE INVENTION

A structural system is provided which includes a building unit which comprises at least a pair of opposed upstanding spaced apart concrete wall slabs which support at least one concrete floor slab thereon. The floor slab is connected directly to the wall slabs by the use of bolting means and tie plates embedded in the wall and floor slabs. The end portions of the floor slab have recesses therein which preferably have tie plates extending across at least a portion thereof. The top portions of the supporting wall slabs also have tie plates protruding therefrom. Both the wall slab and floor slab tie plates have apertures therein which during erection are aligned to form through holes through which the bolting means are connected to form a self-supporting building unit.

In such a structural system, adjacent building units share a common wall slab and the adjacent end portions of the adjacent floor slabs associated therewith are directly connected to each other and to the common wall slab by, once again, aligning the apertures in the associated tie plates during erection so as to form through holes. Bolting means are connected through the adjacent tie plates so as to directly connect the adjacent floor slabs to each other and to the common supporting wall slab.

The building units in such a structure may preferably include a plurality of floor slabs supported between a pair of common wall slabs with the floor slabs serially arranged along the length of the wall slabs. In such an arrangement, the end portions of the floor slabs are connected to the supporting wall slabs by means of associated tie plates in the manner previously described above. The adjacent side portions of the adjacent floor slabs in such an arrangement have recesses therein which are in communication with each other and which have flat plates having apertures therein extending thereacross. The adjacent floor slab side portions are connected to each other by means of connector plates having apertures therein which, during erection, are aligned in the communicating recesses with the respective plate apertures so as to form through holes. Bolting means are then connected through these through holes so as to directly connect the adjacent floor slabs to the connector plate and, thus, to each other.

Such a building structure may also include shear walls as well as the aforementioned bearing or supporting walls. These shear walls are concrete wall slabs normal to the supporting wall slabs and are preferably provided at a location along the longitudinal axis of the building structure. The side portions of the floor slabs adjacent a shear wall slab are directly connected thereto in the manner previously described with reference to the interconnection of adjacent side portions of floor slabs; that is, by means of connector plates, a recess and a flat plate being provided in the upstanding shear wall slab. The interconnection of the floor slab and the shear wall slab enables laterally applied loads across the floor slabs to be transferred to the shear wall slab and, therefrom, to be vertically transferred downwardly towards the building foundation. A plurality of shear wall slabs are connected top to bottom by means of tie plates and bolting means to vertically transfer laterally applied loads between the shear wall slabs.

In constructing such a structural system, the supporting wall slabs are preferably anchored to the wall or

foundation below by bolting, the appropriate floor slabs are then placed thereon and aligned and the adjacent side portions thereof directly connected together also by bolting, and, there-after, the end portions of these wall slabs are directly con-nected to the supporting wall slabs by bolting to complete the erection of a floor. Thereafter, this procedure is repeated for the next subsequent floor and so on until the building is completed.

BRIEF DESCRIPTION OF DRAWINGS

FIG. 1 is a fragmentary typical floor plan of a structure constructed in accordance with the present invention;

FIG. 2 is a partial perspective view of a typical structure in accordance with the preferred embodiment of the present invention;

FIG. 3 is an exploded perspective view similar to FIG. 2;

FIG. 4A is a front elevation of a preferred embodiment of a typical shear wall slab in accordance with the present invention;

FIG. 4B is a plan view of the shear wall slab shown in FIG. 4A;

FIG. 5 is a front elevation of a preferred typical bearing wall slab in accordance with the present invention;

FIG. 6 is a plan view of a preferred typical floor slab in accordance with the present invention;

FIG. 7 is a fragmentary cross-sectional view of a preferred typical anchor connection between adjacent brearing wall slabs and floor slabs in accordance with the present invention;

FIG. 8 is a fragmentary side elevation of the arrangement shown in FIG. 7;

FIG. 9 is a fragmentary plan view of the arrangement shown in FIG. 7;

FIG. 10 is a fragmentary sectional view similar to FIG. 7 of the interconnection of adjacent floor slabs at a bearing wall slab;

FIG. 11 is a fragmentary side elevation of the arrangement shown in FIG. 10;

FIG. 12 is a fragmentary plan view of the arrangement shown in FIG. 10;

FIG. 13 is a fragmentary cross-sectional view of a preferred typical anchor connection between adjacent end bearing wall slabs and a floor slab;

FIG. 14 is a fragmentary cross-sectional view similar to FIG. 13 of a preferred typical connection of an end bearing wall slab to an adjacent floor slab;

FIG. 15A is a fragmentary cross-sectional view of a typical preferred connection between adjacent floor slab side portions or a floor slab to shear wall slab interconnection;

FIG. 15B is a fragmentary plan view of the arrangement shown in FIG. 15A; and

FIG. 16 is a fragmentary cross-sectional view of a preferred typical shear wall slab to shear wall slab interconnection in accordance with the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring now to the figures in detail and especially to FIGS. 1 through 3 thereof, a typical arrangement of the preferred structural system of the present invention, generally referred to by the reference numeral **20**, is shown. Generally describing the structural system **20** of the present invention, a typical preferred structure preferably includes pairs of spaced apart substantially planar upstanding concrete bearing wall slabs, eight such slabs **22, 24, 26, 28, 30, 32, 34** and **36** being illustrated by way of example in FIG. **1**, upon which a plurality of preferably flat planar concrete floor slabs are preferably supported and secured thereto. Twenty such typical floor slabs **38** through **76** inclusive are shown illustratively either in whole or in part in FIG. **1** by way of example.

As will be described in greater detail hereinafter, such a structure **20** may preferably also include shear wall slabs **78**, which are preferably normal to the bearing wall slabs **22** through **36** inclusive and which are preferably located along the longitudinal axis of the building structure **20**.

Referring now to FIGS. **2** and **3**, and to be described in greater detail hereinafter, a typical pair of bearing wall slabs **22** and **24** have floor slabs **46, 48** and **50** and floor slabs **54, 56** and **58** supported thereon with bearing wall slab **24** being a common supporting wall slab for these floor slabs. Each of the floor slabs includes a pair of opposed end portions **80** and **82**, a pair of opposed side portions **84** and **86** and a top portion **88** and an opposed bottom portion **90**. The same reference numerals will be utilized for each of these respective portions for each of the floor slabs, each particular floor slab respective portions being differentiated by means of subscripts a, b, c, d, e, f, g, h, j, k, m, n, p, q, r, s, t, v, w and x for floor slabs **38** through **76**, respectively, with a single respective subscript being associated with only one floor slab.

Before describing a typical structure **20** constructed in accordance with the present invention, the component shear wall slabs, bearing wall slabs and floor slabs utilized in constructing such a structure **20** shall be described with reference to FIGS. **4A, 4B, 5** and **6**, respectively. Referring initially to FIGS. **4A** and **4B**, a typical preferred shear wall slab, such as shear wall slab **78**, is shown by way of example. Preferably, such a shear wall slab **78** is formed from concrete and has a plurality tie plates **100, 102, 104, 106, 108** and **110**, shown by way of example, embedded therein, preferably during the casting of the concrete shear wall slab **78**, such tie plates preferably being composed of rigid structural steel. Preferably, tie plates **100** and **102** are spaced apart on the top portion of the shear wall slab so as to be located respectively adjacent the end portions **112** and **114** of the shear wall slab **78**. These tie plates **100** and **102** preferably are upstanding and protrude from the top portion **111** of the shear wall slab **78**. Each of the tie plates **100** and **102** preferably has a plurality of apertures therein, five such apertures **116, 118, 120, 122** and **124** for plate **100** and **126, 128, 130, 132** and **134** for plate **102** being shown by way of example in FIG. **4A**. Similarly, plates **108** and **110** have apertures therein, one such aperture **136** for plate **108** and **138** for plate **110** being shown by way of example. Plates **108** and **110** are also preferably spaced apart towards the center of the shear wall **78** and are preferably located in recesses **140** and **142**, respectively, formed in the top portion **111** of the shear wall slab **78**. The tie plates **104** and **106**, which are preferably structurally similar to tie plates **100** and **102** are preferably located in the same relative positions along the slab **78** bottom portion **144** with respect to end portions **112** and **114** as tie plates **100** and **102**, respectively, for a purpose to be described in greater detail hereinafter.

Thus, tie plate **104** is preferably located at the same distance from end portion **112** as tie plate **100** and is preferably of the same extend and tie plate **106** is located at the same distance from end portion **114** as tie plate **102** and is preferably of the same extent. Furthermore, tie plate **104** preferably has the identical number of apertures, **146, 148, 150, 152** and **154** in the example shown, as tie plate **100,** each of these apertures preferably being spaced apart from each other and from end portion **112** as corresponding apertures **116** through **124** of tie plate **100** for a purpose to be described in greater detail hereinafter.

Similarly, tie plate **106** preferably includes the identical number of apertures, **156, 158, 160, 162** and **164** in the example shown, as tie plate **102,** which apertures are spaced apart from each other and from end portion **114** preferably at the same distances as corresponding apertures 126 through 134 in tie plate **102** for a purpose to be described in greater detail hereinafter.

In addition, as will be described in greater detail hereinafter, the location of tie plate **104** on bottom portion **144** with respect to tie plate **100** on top portion **111** is offset from each other (see FIG. **16**) as is the respective locations of tie plates **106** and **102.** As shown and preferred in FIG. **4A**, tie plates **104** and **106** are preferably located in recesses **166** and **168,** respectively, formed in the bottom portion **144** of the shear wall slab **78.** The interconnection of adjacent shear wall slabs will be described with reference to FIG. **16** in greater detail hereinafter and the interconnection of an adjacent floor slab and shear wall slab will be described in greater detail hereinafter with reference to FIGS. **15A** and **15B.**

Referring now to FIG. **5,** a typical preferred bearing wall slab, such as bearing wall slab **24,** is shown by way of example in FIG. **5.** Preferably, all the bearing wall slabs are of substantially the same configuration and will not be described in greater detail hereinafter. The bearing wall slab **24** has a top portion **170** and opposed bottom portion **172,** a pair of opposed end portions **174** and **176** and a pair of opposed side portions **178** and **180.** Preferably, a plurality of tie plates, which are preferably composed of rigid structural steel, are embedded in the concrete bearing wall slab **24** during the casting thereof. These tie plates, eight such tie plates **182, 184, 186, 188, 190, 192, 194** and **196** being shown by way of example, preferably protrude from the top portion **170** of the bearing wall slab **24.** Each of these tie plates **182** through **196** inclusive preferably has an aperture therein, one such aperture **198** through **212,** respectively, being shown by way of example in each of the tie plates **182** through **196** inclusive. Each of the tie plates **182** through **196** inclusive are longitudinally spaced apart along the top portion **170** of the bearing wall slab **24.** Preferably, at least two of these tie plates, **186** through **194,** have bolting means **214** and **216,** respectively, protruding from the top portion thereof for direct interconnection of this bearing wall slab to an overlying bearing wall slab which will be described in greater detail hereinafter with reference to FIGS. **7** through **9.** Preferably, these anchor tie plates **186** and **194** are located near the end portions **176** and **174,** respectively, of bearing wall slab **24.**

As shown and preferred in FIG. **5,** the bottom portion **172** of bearing wall slab **24** includes a pair of spaced apart recesses **218** and **220** which are preferably located, respectively, at the same longitudinal position from respective end portions **176** and **174** as anchor tie plates **186** and **194,** respectively. Each of these recesses **218** and **220** preferably includes a flat rigid plate **222** and **224,** respectively, preferably composed of structural steel, each having a pair of apertures **226** and **228** for plate **222** and **230** and **232** for plate **224** which are preferably located at the same longitudinal position as corresponding bolting means **214** and **216,** respectively, for direct interconnection with an underlying bearing wall slab in the manner illustrated in FIGS. **7** through **9.**

Referring now to FIG. **6,** a typical preferred concrete floor slab **58** is shown by way of example, all floor slabs in the structural system of the present invention preferably being substantially identical in structure. Preferably, each of the end portions **80***m* and **82***m* of floor slab **58** each include a pair of spaced apart tie plates **240** and **242** for end portion **80***m* and **244** and **246** for end portion **82***m.* As shown in FIGS. **9** and **12** and as will be described in greater detail hereinafter, each of these tie plates **240** through **246** inclusive preferably consists of a tubular piece of structural steel which has been embedded in the concrete floor slab **58** preferably during the casting thereof and which also preferably includes an aperture extending through the outermost portion thereof. The preferred shape of this tubular tie plate **240** to **246** inclusive can be obtained by reference to FIGS. **7, 9, 10,** and **12** which will be referred to in the detailed explanation of the direct interconnection of the floor slabs to the bearing wall slabs.

As also shown and preferred in FIG. **6,** each of the side portions **84m** and **86m** of the floor slab **58** includes a plurality of recesses therein, **248, 250** and **252** for side portion **84***m* and **254, 256** and **258** for side portion **86***m.* As can be seen by reference to FIGS. **15A** and **15B,** each of these recesses **248** through **258** inclusive preferably includes a structural steel plate, such as one formed of angle iron structural steel embedded in the concrete during the casting of the floor slab. As can be seen with reference to FIG. **15A,** the recesses **248** through **258** are preferably notches in the side portions **84***m* and **86***m* and do not extend completely between the top portion **88***m* and the bottom portion **90***m* of the floor slab **58.** Each of the plates **260** through **270** inclusive located in the recesses **248** through **258** inclusive preferably include a pair of spaced apart apertures therein as illustrated in FIG. **15B** for enabling direct interconnection of adjacent side portions of adjacent floor slabs in a manner to be described in greater detail hereinafter.

Now that the typical shear wall slab **78,** bearing wall slab **24** and floor slab **58** have been described in greater detail above, the various interconnections of these components in the structural system **20** of the present invention shall be described in greater detail hereinafter with reference to FIGS. **7** through **16.**

ANCHOR CONNECTION BETWEEN BEARING WALL SLABS AND FLOOR SLABS

Referring now to FIGS. **7** through **9,** a typical preferred anchor connection between adjacent bearing wall slabs and floor slabs is shown. By the use of the term anchor connection it is meant that the upper bearing wall slab **272** is physically secured to the lower bearing wall slab **22** and is, therefore, anchored thereto. The upper bearing wall slab **272** shown by way of example in FIG. **7** is omitted from FIGS. **2** and **3** for

clarity and is mounted in the structure **20** illustrated in FIG. **2** preferably spaced apart from bearing wall slab **274** illustrated therein and is anchored to lower bearing wall slab **24** in the manner illustrated in FIGS. **7** through **9.** In securing the upper bearing wall slab **272** directly to the lower bearing wall slab **24** and the adjacent end portions **82**g and **80**m of floor slabs **50** and **58,** respectively, together, the floor slabs **58** and **50** are preferably placed on the lower supporting bearing wall slab **24.** As shown and preferred in FIG. **7,** anchor plate **186** protruding from the top portion of bearing wall slab **24** is preferably located in the center of the top portion along the longitudinal axis of the top portion of bearing wall slab **24** so as to provide an equal supporting surface for the adjacent end parts of floor slabs **50** and **58,** respectively.

The tie plates **246** and **244** for end portion **82**g of floor slab **50** are placed on top of bearing wall slab **24** with the aperture in one of these tie plates aligned with the aperture **202** in anchor plate **186,** and the other tie plate aperture aligned with the aperture in another bearing wall slab **24** tie plate, such as plate **188** whose interconnection will be described in greater detail hereinafter with reference to FIG. **10.** The upper bearing wall **272** is preferably placed on top of lower bearing wall **24** by aligning the apertures **226** and **228** in plate **222** at the bottom portion of bearing wall **272** with the bolts **214** protruding from anchor plate **186.** As shown and preferred, preferably a cement asbestos shim **276** is initially placed on the floor slabs **50** and **58** over the bolts **214** prior to the placement of the plate **222** thereover to provide additional support during erection. The upper bearing wall **272** is then secured to the lower bearing wall **24** by means of tightening a nut **278** on each of the bolts or studs **214,** which are preferably threaded, until the desired proof of load is obtained and a desired relative position between the bearing wall slabs **272** and **24** and the floor slabs **50** and **58** is achieved. The adjacent floor slabs **50** and **58** are directly secured to each other and to the supporting bearing wall slab **24** by means of threading a bolt **280** through the aligned apertures in the tie plates **246** and **242** and anchor plate **186,** which apertures form a through hole, the bolt **280** having a head **284** preferably being threaded, and thereafter tightening nut **282** on bolt **280** until the desired proof of load is obtained and the slabs are directly secured together in a desired predetermined position relative to each other.

This connection is likewise repeated for the opposite end portions of floor slabs **50** and **58,** respectively. Thus, this anchor connection is resistant to the collapse of either floor slab **50** or **58,** such as due to local explosion and in the event of such collapse the remaining floor slab and bearing wall slabs will still be fixedly secured together in position by the bolting arrangements previously described. These bolting arrangements provide a direct interconnection between the upper and lower bearing wall slabs and the adjacent floor slab end portions.

As shown and preferred in FIG. **7,** in order to tighten the interconnection between the adjacent end portion of the floor slabs **50** and **58,** conventional steel shims **286** and **286'**, respectively, may be driven in conventional fashion between the end portion **82**g and anchor tie plate **186,** and between the end portion **80**m and anchor tie plate **186,** respectively, in order to fill any gap existing therebetween. Furthermore, as shown and preferred, if desired, cement asbestos cloth bearing pads **288** and **290** may be placed on top of the lower supporting bearing wall slab **24** between the top surface thereof and the bottom surface of the end parts of the floor slabs **50** and **58** resting thereon in order to compensate for any irregularities in these surfaces. Preferably, all anchor connections between bearing wall slabs and floor slabs, other than end bearing wall anchor connections, are accomplished in this manner in the structural system **20** of the present invention.

FLOOR SLAB TO FLOOR SLAB CONNECTION ON UNANCHORED BEARING WALL PORTION

Referring now to FIGS. **10** through **12,** a typical preferred direct interconnection between adjacent floor slab end portions supported on the bearing wall slab at a point along the bearing wall slab other than where the lower bearing wall slab **24** is anchored to the upper bearing wall slab **272** at anchor tie plates **186** and **194** is shown, such as at tie plate **188** on bearing wall slab **24.** As was previously mentioned, the upper bearing wall slab **272** is preferably only anchored to lower bearing wall slab **24** at two points adjacent the ends of the lower bearing wall slab **24,** these points being at anchor tie plates **186** and **194,** respectively, via associated plates **222** and **224,** respectively, of upper bearing wall slab **272.** The direct interconnection of the adjacent end portions **82**g of floor slab **50** and **80**m of floor slab **58** are preferably interconnected in the same manner as previously described with reference to FIG. **7** with the exception that tie plate **188** is the plate to which the end portions are fastened rather than anchor tie plate **186.** Once again, tie plates **240** and **244** associated with the end portions **80***m* and **82***g* of floor slabs **58** and **50,** respectively, are preferably tubular structural steel. The end parts of the floor slabs **50** and **58** are placed on the top surface portion of lower supporting bearing wall slab **24** and the apertures in tie plates **240** and **244,** respectively, are aligned with the aperture **204** in tie plate **188,** as previously mentioned. Thereafter, a bolt **292** having a head **294** is threaded through the through hole formed by these apertures and a nut **296** is threaded thereon and tightened to proof the load until the desired predetermined relationship between the adjacent floor slab end portions is obtained.

As shown and preferred (see FIG. **10**), the tie plate **188** is also preferably located in the center of the top surface of supporting bearing wall slab **24** along the longitudinal axis thereof as are all of the tie plates **182** through **196** inclusive. In addition, as was previously mentioned with respect to the anchor interconnection of the bearing wall slabs, conventional steel shims **298** and **300,** respectively, may be conventionally driven between end portion **82***g* of floor slab **50** and tie plate **188** and end portion **80***m* of floor slab **58** and tie plate **188,** respectively, to further tighten the connection and fill any gap formed therebetween. Thus, in the example previously described, floor slab **58** has its end portion **80***m* directly secured to the supporting bearing wall slab **24** at tie plates **186** and **188,** respectively, by means of bolts **280** and **292,** respectively. Furthermore, upper bearing wall slab **272** is anchored to lower bearing wall slab **24** at anchor tie plates **186** and **194** by means of bolts **214** and **216** and associated nuts **278** in the manner previously described above.

Preferably, the direct interconnection of floor slabs at the bearing wall slabs throughout the structural sys-

tem 20 of the present invention is preferably as shown and described with reference to FIGS. 10 through 12 except at the anchor connections between an upper bearing wall slab and a lower bearing wall slab or the foundation of the structure where the interconnection is preferably as shown and described previously with reference to FIGS. 7 through 9.

ANCHOR CONNECTION BETWEEN END BEARING WALL AND FLOOR SLAB

Referring now to FIG. 13, a typical preferred anchor connection between an end bearing wall slab, that is a bearing wall slab at the extremities of the structure 20, and an adjacent floor slab is shown. Preferably, the direct interconnection of the upper bearing wall slab 310 to the lower supporting bearing wall slab 312 is similar to that previously described with reference to FIGS. 7 through 9 wherein the direct interconnection of bearing wall slabs other than bearing wall slabs is described. The primary difference between the lower supporting end bearing wall slab 312 and a typical supporting bearing wall slab 24 is in the configuration of the upper portion thereof. As shown and preferred in FIG. 13, rather than being symmetrical about the tie plate 314 which protrudes from the upper surface of bearing wall slab 312, the bearing wall slab 312 upper portion is formed with a notch-like arrangement for receiving a floor slab on the innermost side of the tie plate 314 and provides a flush concrete surface 316 on the opposite side so as to provide an outer wall for the structure. This portion is formed with a recess 318 adjacent the tie plate 314 which closes this recess, except for an aperture 320 in tie plate 314. A bolt 322 having a head 324 is threaded through this aperture 320, apertures 320 being aligned with an aperture in tie plate 242 embedded in floor slab 330 to form a through hole therebetween, and is fastened in position by means of tightening a nut 332 to proof the load until the floor slab 330 is in a desired predetermined position with respect to supporting bearing wall slab 312.

As was previously mentioned, a conventional steel shim 334 may be driven in conventional fashion between tie plate 242, which is preferably a tubular structural steel tie plate located at the end portion 80 of floor slab 330, and the tie plate 314 to tighten the interconnection and fill any gap therebetween. Tie plate 314 is preferably an anchor tie plate identical with either anchor plate 186 or 194 and has a bolt assembly 340 protruding therefrom. The upper bearing wall slab 310 is mounted on the lower bearing wall slab 312 by aligning the apertures in the associated plates 222 or 224 with the respective bolt assembly 340. After the bolt assembly 340 is passed through the respective apertures, nuts 342 are tightened to proof the load to the desired amount until the bearing wall slabs 310 and 312 and the floor slab 330 are in the preferred predetermined position relative to each other. As was previously mentioned, if desired a cement asbestos shim 344 may be placed over the bolt assembly 340 between the plate 222 and the upper surface of floor slab 330 and supporting bearing wall slab 312 to provide temporary support during erection although remaining in position in the structure thereafter. Preferably, all end bearing wall anchor connections with floor slabs are accomplished in this manner in the structural system 20 of the present invention.

FLOOR SLAB TO END BEARING WALL INTERCONNECTION

Referring now to FIG. 14, a typical preferred direct interconnection between and end bearing wall slab and a floor slab along the supporting bearing wall slab top surface at a point other than where the anchor connections of the upper and lower bearing wall slabs occur is shown. The direct interconnection of the floor slab 330 to the lower supporting bearing wall slab 312 is preferably identical to that previously described above with reference to FIG. 13 with the exception that the tie plate 350 does not have a bolt assembly protruding therefrom so that there is no such means for interconnecting the upper bearing wall slab 310 to the lower supporting bearing wall slab 312 at this point. Other than the direct interconnection of the floor slab 330 to the bearing wall slab 312 is accomplished in the manner previously described with reference to FIG. 13 and will not be described in greater detail hereinafter. Suffice it to say that the tubular structural steel tie plate 240 located at one end 80 of the floor slab 330 is aligned with the aperture 352 in tie plate 350, the configuration of the end bearing wall slab 312 at this point preferably being identical with that previously described with reference to FIG. 13 at the point of anchor connection between the upper and lower bearing wall slabs 310 and 312. A bolt 354 having a head 356 is threaded through the through hole formed by the aperture in tie plate 240 aligned with the aperture 352 in tie plate 350 and a nut 358 is tightened to proof the load to the desired value and secure the floor slab 330 end portion at this point in the preferred relative position with respect to supporting wall slab 312. As was also previously mentioned, if desired, a conventional steel shim 360 may be conventionally driven between end portion 80 and tie plate 350 to further tighten the interconnection between the floor slab 330 and the bearing wall slab 312 and to fill any gap therebetween.

As was also previously mentioned, as asbestos cloth 362 may be placed on the top surface of the supporting bearing wall slab 312 between this surface and the abutting bottom surface of floor slab 330 to compensate for any irregularities in the concrete as was also true with respect to bearing pads 302 and 304 referred to with reference to FIG. 10 and bearing pads 288 and 290 referred to with reference to FIG. 7 and bearing pad 346 referred to with reference to FIG. 13. Preferably, the direct interconnection of floor slab to end bearing wall slab throughout the structural system 20 of the present invention is preferably as shown and described with reference to FIG. 14 except at the anchor connections between an upper end bearing wall slab and a lower end bearing wall slab or the foundaton of the structure where the interconnection is preferably as shown and described previously with reference to FIG. 13.

SLAB TO SLAB SIDE CONNECTION

Referring now to FIGS. 15A and 15B a typical preferred interconnection between adjacent side portions of adjacent floor slabs or an adjacent side portion of a floor slab and an adjacent shear wall slab is shown. By way of example, a typical interconnection between the side portions of adjacent floor slabs 48 and 46 is shown. The adjacent floor slabs 48 and 46 have their side portions 86*f* and 84*e*, respectively, adjacent each other and

preferably slightly spaced apart from one another. A connector plate 370, preferably formed of a rigid structural steel having apertures 372 through 378 inclusive therein is preferably placed in the communicating recesses 254 and 248 of floor slabs 48 and 46 with the apertures therein aligned with the apertures in the plates 266 and 260, respectively. Bolts 380 and 382 having heads 381 and 383, respectively, are preferably threaded through the through holes formed by the aligned apertures in connector plate 370 and plate 266, and bolts 384 and 386 having heads 385 and 387, respectively, are threaded through the through holes formed by the aligned apertures in connector plate 370 and plate 260. Therefter, nuts 388, 390, 392 and 394 are tightened on bolts 380, 382, 384, and 386, respectively, to proof the load to the desired value until the adjacent floor slab side portions 86*f* and 84*e* are in the preferred predetermined relationship to each other. In this manner, connector plate 370 also acts to level the adjacent floor slabs with respect to each other as well as to interconnect the ajacent slab side portions.

Preferably, if desired, at some time subsequent to the interconnection of the floor slabs, the gaps existing therebetween may be filled with conventional grouting although such grouting is not necessary for structural support. As was previously mentioned, a floor slab may be connected to a shear wall slab, such as shear wall slab 78, in this manner with a connector plate 370 connecting the floor slab to a plate in a recess at the top of the adjacent shear wall slab, such as plate 136 in recess 108 or plate 138 in recess 110, so as to transfer any loads laterally transferred across the floor slab to the shear wall slab where, thereafter, these loads may be vertically transferred downwardly through the structure. Furthermore, the interconnection of adjacent floor slabs in the manner previously described above serves to laterally transfer and distribute loads throughot the structure. Preferably, all side connections between adjacent floor slabs and all side connections between adjacent floor slabs and shear wall slabs are accomplished in this manner in the structural system 20 of the present invention.

SHEAR WALL TO SHEAR WALL INTERCONNECTION

Referring now to FIG. 16 a typical preferred arrangement for interconnecting an upper shear wall slab 400 to a lower shear wall slab 78 is shown. As was previously mentioned with reference to FIGS. 4A and 4B, the upper tie plates 100 and 102 of a typical shear wall slab 78 are offset from the lower tie plates 104 and 106 of the typical shear wall slab. Consequently, when these shear wall slabs are preferably placed one on top of the other, the adjacent tie plates, such as 100 and 104, are aligned next to each other to form corresponding through hole pairs of apertures 116–146, 118–148, 120–150, 122–152, and 124–154. This arrangement likewise holds for adjacent tie plates 102 and 164 forming through hole pairs of apertures 126–156, 128–158, 130–160, 132–162, and 134–164. Bolts such as typical bolt 402 having a head 404 thereon are preferably threaded through the respective aperture pairs and associated nuts 406 are tightened thereon to proof the load to a desired value so as to directly connect the upper and lower shear wall slabs 400 and 78 together in a predetermined position relative to each other. In this manner applied loads which are transferred to an upper shear wall slab connected to an adjacent floor slab at the side portion thereof, such as in the manner previously described with reference to FIGS. 15A and 15B, are then vertically transferred from the upper shear wall slab to the lower shear wall slab and so forth downwardly throughout the structure 20 to the foundation. Thus, laterally applied loads across the floor slabs are vertically transferred through the structure by means of the shear wall slabs.

Now generally describing the preferred manner of constructing a building structure 20 in accordance with the present invention. Preferably, the foundation for the building comprises a plurality of slabs each having upstanding anchor tie plates similar to anchor plates 186 and 194. If desired, wall supporting shim pads similar to shim pad 276 may be placed over the bolt assembly associated with these anchor plates so as to provide a true level base for the next lift of wall slabs. A bearing wall slab is then lifted into position using the projecting bolt assembly, such as bolt assembly 214, from the lower wall slab or foundation slab anchor plate as a guide, the associated plates 222 and 224 being aligned with these bolt assemblies so as to have the bolt assemblies pass through the apertures therein. The bearing wall slab is installed to line and braced to plumb. The anchor connection of this bearing wall slab to the underlying foundation slab or lower supporting bearing wall slab is then made by tightening the appropriate nuts, such as nut 278, such as by a conventional torque wrench. In this manner the upper bearing wall slab is anchored to the foundation or to the bearing wall slab below if a floor above the foundation is being constructed.

The floor slabs are then lifted into position on appropriate spaced apart pairs of bearing wall slabs and their respective end portion tie plates are aligned with those of the supporting bearing wall slabs upon which the floor slab rests so as to align the apertures therein with the apertures in the tie plates protruding from the supporting bearing wall slab so as to form through holes. This is repeated for all of the floor slabs to be supported between the bearing wall slabs, the floor slabs being serially arranged side to side along the length of the bearing wall slabs. Thereafter, the adjacent side portions of the floor slabs are interconnected in the manner illustrated in FIGS. 15A and 15B by the insertion of appropriate connector plates 370 and the tightening of nuts 388 through 394 associated with the plates 260 through 270 inclusive. After the adjacent side portions of the adjacent floor slabs are directly connected together by these bolts connections, the end portions of the floor slabs are connected to the associated tie plates of the lower supporting bearing wall slab, such as slab 24, in the manner previously described with reference to FIGS. 7 through 9 if the associated tie plate is an anchor tie plate, and in the manner previously described with reference to FIGS. 10 through 12 if the associated bearing wall slab tie plate is not an anchor plate.

Preferably, when a complete bay of floor slabs is installed, a bay being defined as a pair of bearing wall slabs and the required plurality of floor slabs necessary to cover the length of the bearing wall slabs, the steel shims, if desired, are driven. This is preferably done prior to the bolting of the end portions of the floor slabs to the lower supporting bearing wall slab. This completes the erection cycle for a given bay and erection can then proceed to the next bay or floor, although it

should be noted that adjacent bays share a common wall slab therebetween and the adjacent end portions of the floor slabs are interconnected to the common tie plates on the common bearing wall slab in the manner previously described with reference to FIGS. 7 and 10. Similarly, if the structure contains shear wall slabs then the tie portions of the floor slabs adjacent thereto are interconnected thereto in the manner previously described with reference to FIGS. 15A and 15B. Such a typical shear wall slab 78 is shown in the fragmentary floor plan view of FIG. 1. It should be noted that preferably the shear wall slabs are located along the longitudinal axis of the structure and do not extend the entire width of the structure but rather only a portion thereof although preferably vertically extending substantially the entire height of the structure.

In a structure 20 constructed in accordance with the present invention wherein the various slabs are directly interconnected by mechanical means such as the preferred bolt assemblies, and wherein the slabs are all preferably precast concrete slabs tied together by dry mechanical joints comprising the bolt assemblies, lateral loads are transferred across the floor slabs onto the bearing wall slabs or shear wall slabs which, in turn, resist the cumulative shear and overturning moments applied to the structure. For example, the horizontal lateral loads are transferred across the floor slabs and subsequently onto the shear wall slabs by dry mechanical joints which create a friction connection therebetween capable of transferring lateral shear between the connected elements such as floor slab to floor slab or floor slab to shear wall slab. Once the lateral loads are transferred onto the shear wall slab, the shear wall slab itself transfers the cumulative loads vertically down onto the next similar slab and subsequently into the foundations of the structure. Once again, the vertical transfer of shear and tension/compression forces, produced by the overturning moments, is preferably achieved by dry mechanical joints. The shear wall slabs are interconnected by the dry mechanical joints which create a friction connection capable of transferring the combined tension/compression shear loads downwards. The bearing wall slabs transfer shear by friction along their bearing surfaces and resist tension forces due to overturning moments preferably also by dry mechanical joints. Such a system has high resistance to wind and earthquake loads. In addition, the system is preferably ductile and preferably oversizing all bolt holes so that the system can move under catastrophic loading with considerable energy absorption before the building structure reaches its ultimate capacity. For example, the oversizing of the bolt holes may be 30 to 100 percent of the bolt diameter. Furthermore, in the preferred structural system of the present invention progressive collapse is prevented due to the interconnection of the floor slabs to the bearing wall slab so that when a floor slab collapses on one side of the bearing wall slab, the wall slab is held by the floor slab and its connections on the opposite side. In addition, this system enables automatic leveling of adjacent floor slabs by means of the connector plates previously described in the discussion relating to the side to side floor slab interconnection. Due to the rigidity of this connector plate, adjacent floor slabs may be brought level without recourse to shoring or loading of the slabs. Furthermore, the floor slabs and interconnected bearing wall slabs form self-supporting structural building units capable of transferring lateral and vertical loads during erection so that after the interconnection of the various bolt assemblies to the associated tie plates and connector plates, the relevant floor in the structure has the essential rigidity to be self-supporting vertically and laterally so that the bracing below the floors can immediately be removed as soon as the floor slabs are installed and the connections are bolted.

Another advantage of the present invention is that by utilizing dry mechanical joints during the erection process the erection process may be an all-weather erection process since any grouting or welding which may be required is a non-essential part of the erection process and can be done any time afterwards. For example, several floors can be erected in such a structure before any dry packing under the walls or grouting is utilized. Furthermore, preferably, the different types of slabs utilized in the preferred structural system of the present invention are kept to a minimum so that the manufacturing process thereof can be largely repetitive. Thus, in accordance with the present invention, a simplified and rapid erection process requiring a minimum of on site work and skilled site labor and a minimum of post-erection completion work may be accomplished with the resultant structure highly resistant to wind and earthquake loads, the resultant structure acting as a membrane connected to the shear and bearing walls to establish permanent structural stability during construction after the completion of each floor slab. Furthermore, the structural system of the present invention enables the construction of a building structure by the direct interconnection of concrete slabs without the requirement of a structural steel framework for the structure.

It should be understood that as used throughout the specification and claims the term "direct connection" is meant to define a connection wherein the connected members are in mutually supporting relationship and do not rely for support on an intervening frame. Thus, direct connection could include connection through an interposed member as in FIGS. 15A and 15B so long as that member is not a portion of a supporting frame.

It is to be understood that the above described embodiments of the invention are merely illustrative of the principles thereof and that numerous modifications and embodiments of the invention may be derived within the spirit and scope thereof, such as by cantilevering balcony floor slabs off the end bearing wall slabs of the structure.

What is claimed is:

1. A method of constructing a self-supporting building unit which includes at least a first upstanding substantially planar concrete wall slab having a top portion, an opposed bottom portion, a pair of opposed side portions and a pair of opposed end portions; and a first substantially flat planar floor slab having a top portion, an opposed bottom portion, a pair of opposed end portions and a pair of opposed side portions, said wall slab top portion having an upstanding tie plate means protruding therefrom and at least partially embedded therein, said tie plate having an aperture therein; at least one of said first floor slab end portions having a recess therein, a tie plate means extending across at least a portion of one of said first floor slab end portions having a recess therein, a tie plate means extending across at least a portion of said recess and at least partially embedded in said first floor slab end portion

said first floor slab tie plate having an aperture therein; said method comprising the steps of placing said first floor slab one end portion on top of said wall slab top portion with said first floor slab bottom portion adjacent said first floor slab end portion in direct bearing load relationship on said wall slab top portion, substantially aligning said tie plates adjacent one another and substantially aligning said apertures so as to create a through hole between said tie plates; and directly connecting said first floor slab end portion to said wall slab top portion by initially threading a bolting means through said through hole and tightening said bolting means until said slabs are directly secured in a predetermined position relative to each other with said first floor slab bearing on said wall slab, whereby static load transfer across said first floor slab and down through said wall slab is provided substantially solely by the bearing relationship of said slabs.

2. A method in accordance with claim **1** wherein said building unit includes at least a second substantially flat planar concrete floor slab having a top portion, an opposed bottom portion, a pair of side portions and a pair of end portions, at least one of said second floor slab end portions having a recess therein, a tie plate means extending across at least a portion of said recess and at least partially embedded in said second floor slab end portion, said second floor slab tie plate having an aperture therein; said wall slab top portion having another upstanding tie plate means protruding therefrom and at least partially embedded therein, said wall slab top portion tie plates being spaced apart, said wall slab other tie plate having an aperture therein; at least one of said first and second floor slab side portions each having a recess therein, each of said recesses including a substantially flat plate therein in a given plane and at least partially embedded therein said plates being substantially parallel to said floor slab top portions, each of said plates having at least one aperture therein, wherein said placing step further includes the step of placing said second floor slab one end portion on top of said wall slab top portion with said second floor slab bottom portion adjacent said second floor slab one end portion in direct bearing load relationship on said wall slab top portion and with said second floor slab one side portion adjacent said first floor slab one end portion and with said side portion recesses in communication with each other; said aligning step further includes the step of substantially aligning said second floor slab one end portion tie plate adjacent said wall slab other tie plate and substantially aligning said apertures therein so as to create a through hole between said tie plates; and said direct connection step includes the steps of placing a substantially rigid connector plate means hving a pair of spaced apart apertures within said communicating side portions recesses over said floor slab side portion eportion plates and substantially aligning one of said plate apertures respectively with one of said connector plate apertures so as to create a pair of through holes between said connector plate and said respective side portions plates; directly connecting said adjacent floor slab side portions together by initially threading a bolting means through each of said through holes and tightening said bolting means until said floor slab top portions are substantially aligned and said floor slab adjacent side portions are directly secured in a predetermined position relative to each other; and directly connecting said second floor slab end portion to said wall slab top portion by initially threading another bolting means through said tie plate through hole therebetween and tightening said bolting means until said slabs are directly secured in a predetermined position relative to each other with said first and second floor slabs bearing on said wall slab, whereby static load transfer across said first floor slab and down through said wall slab is provided substantially solely by the bearing relationship of said slabs.

3. a method in accordance with claim **2** wherein said adjacent floor slab side portions are directly connected together after being placed on said wall slab top portion in bearing load relationship thereon and prior to directly connecting said floor slab one end portions to said wall slab top portion.

4. A method in accordance with claim **1** wherein said building unit includes at least one upstanding concrete supporting slab having a top portion with an upstanding bolting means protruding therefrom and at least partially embedded therein, said first wall slab bottom portion having a recess therein, a tie plate means extending across at least a portion of said wall slab bottom portion recess and, being at least partially embedded in said wall slab bottom portion, said tie plate having an aperture therein; wherein said method further comprises the steps of placing said wall slab on top of said supporting slab top portion in bearing load relationship with said wall slab bottom portion being adjacent said supporting said top portion and said supporting slab bolting means extending through said wall slab bottom portion tie plate aperture and said wall slab being braced to plumb; and directly connecting said wall slab to said supporting slab below by tightening said bolting means until said slabs are directly anchored in a predetermined position relative to each other, whereby static load transfer across said first floor slab and down through said wall slab is provided substantially solely by the bearing relationship of said slabs.

5. A method in accordance with claim **4** wherein said wall slab is directly connected to said supporting slab in bearing load relationship thereon prior to placing said floor slab on said wall slab.

6 A method in accordance with claim **4** wherein said building unit includes a second substantially flat planar floor slab having a top portion, an opposed bottom portion, a pair of opposed end portions and a pair of opposed side portions; at least one of said second floor slab end portions having a recess therein, a tie plate means extending across at least a portion of said recess and at least partially embedded in said second floor slab end portion, said second floor slab tie plate having an aperture therein; wherein said method further comprises the steps of placing said second floor slab one portion on top of said supporting slab top portion in direct bearing load relationship on said supporting slab top portion, said upstanding protruding means including a plate having an aperture therein, substantially aligning said second floor slab tie plate aperture and said protruding means plate aperture so as to create a through hole between said plates; and directly connecting said second floor slab end portion to said supporting slab top portion by initially threading a bolting means through said through hole and tightening said bolting means until said supporting slab and said second floor slab are directly secured in a predetermined position relative to each other with said second floor slab bearing on said supporting slab, said placing step

further comprising placing said first wall slab bottom portion in direct bearing load relationship on said second floor slab end portion, said supporting slab upstanding bolting means protruding so as to enable said extension thereof through said first wall slab bottom portion aperture when said first wall slab bottom portion bears on said second floor slab end portion, and fastening said first wall slab to said supporting slab by said upstanding bolting means, static load transfer across said first floor slab and down through said wall slab is provided substantially solely by the bearing relationship of said slabs and static load transfer from said first wall slab to said second floor slab is provided substantially solely by the bearing relationship therebetween and static load transfer from said second floor slab to said supporting slab is proivded substantially solely by the bearing relationship therebetween.

7. A method in accordance with claim **1** wherein said unit includes a second substantially flat planar floor slab having a top portion, an opposed bottom portion, a pair of opposed end portions and a pair of opposed side portions; at least one of said second floor slab end portions having a recess therein, a tie plate means extending across at least a portion of said recess and at least partially embedded in said second floor slab end portion, said second floor slab tie plate having an aperture therein; wherein said method further comprises the steps of placing said second floor slab one end portion on top of said wall slab top portion in direct bearing load relationship on said wall slab top portion and adjacent to said first floor slab one end portion, said first floor slab tie plate being placed adjacent to said wall slab tie plate and said wall slab tie plate being placed adjacent to said second floor slab tie plate and being common to said floor slab tie plates and substantially aligning said apertures so as to create a through hole between all of said tie plates; and said direct connection step includes the further step of directly connecting said floor slab one end portions to each other and to said wall slab top portion by initially threading a bolting means through said through hole and tightening said bolting means until said slabs are directly secured in a predetermined position relative to each other, whereby static load transfer across said first floor slab and down through said wall slab is provided substantially solely by the bearing relationship of said slabs.

8. A method in accordance with claim **1** wherein said wall slab top portion tie plate aperture and said floor slab one end portion tie plate aperture are enlarged with respect to the bolting means extending therethrough in at least one direction and said substantial aperture aligning said enlarged tie plate apertures to compensate for manufacturing and erection tolerances and said tightening step comprises tightening said bolting means so as to enable slippage of said direct connection for rendering said building unit ductile.

9. A method in accordance with claim **1** wherein said building unit includes a shim means having an aperture portion therein and said method further comprises the step of inserting said shim means between said wall slab top position tie plate and said floor slab one end portion tie plate, said aperture aligning step comprises substantially aligning said tie plate apertures and said shim aperture to provide said through hole, and said direct connection step comprises directly connecting said first floor slab end portion to said wall slab portion by initially threading said bolting means through said through hole and tightening said bolting means until said slabs are directly secured in said predetermined position with respect to each other with said tie plates bearing in compression through said shim means interposed therebetween and on tension and sheer through said bolting means.

* * * * *