Nov. 26, 1974 A. S. CULL ET AL 3,851,024

REINFORCED CONCRETE CONSTRUCTION

Original Filed May 6, 1970 5 Sheets-Sheet 1

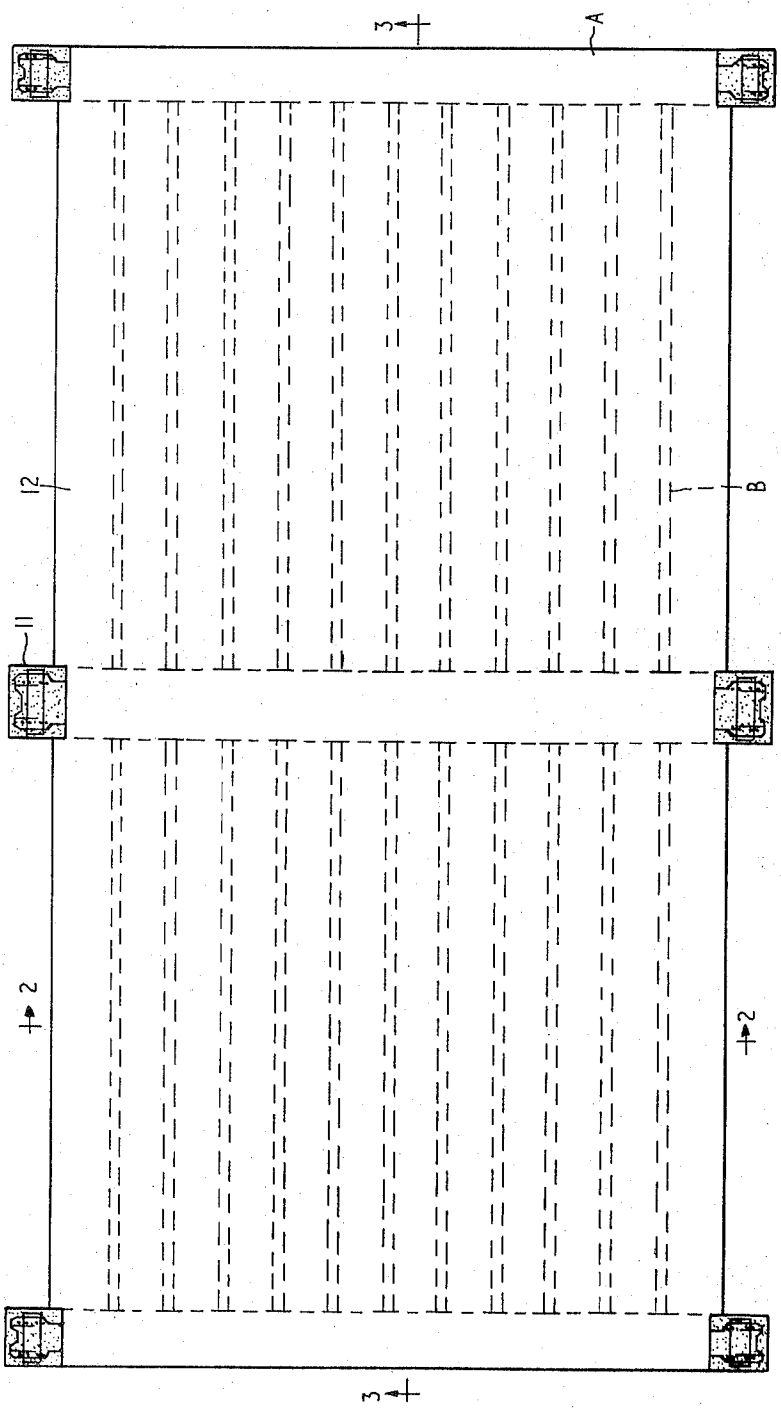

FIG. 1

REINFORCED CONCRETE CONSTRUCTION

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FIG. 2

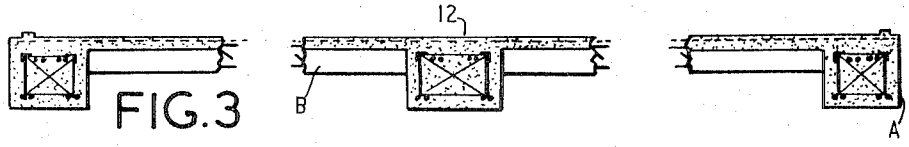

FIG. 3

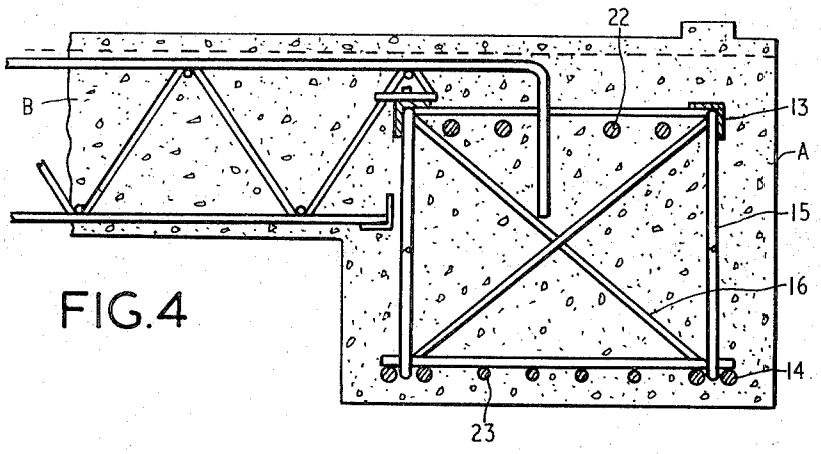

FIG. 4

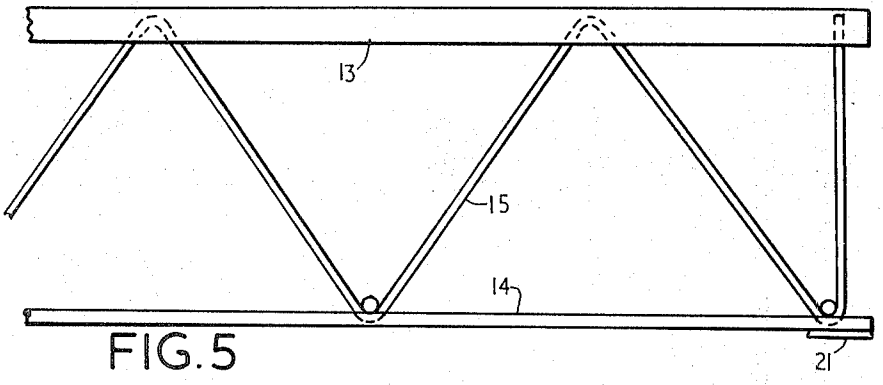

FIG. 5

REINFORCED CONCRETE CONSTRUCTION

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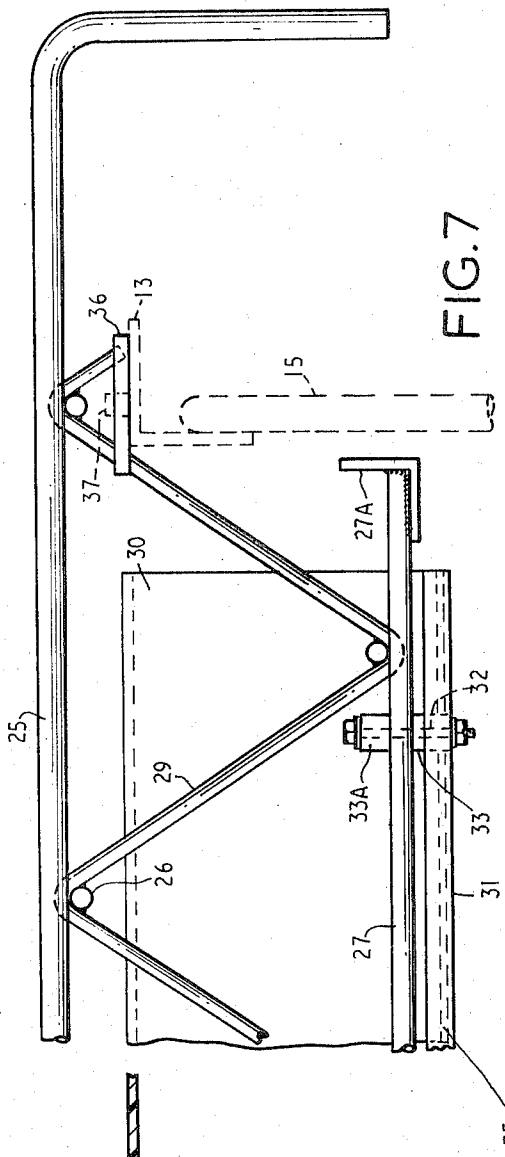

FIG. 7

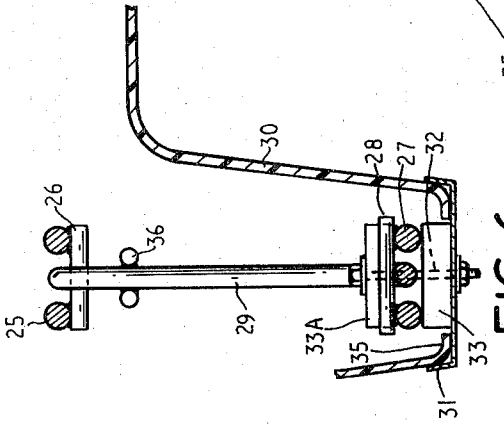

FIG. 6

REINFORCED CONCRETE CONSTRUCTION

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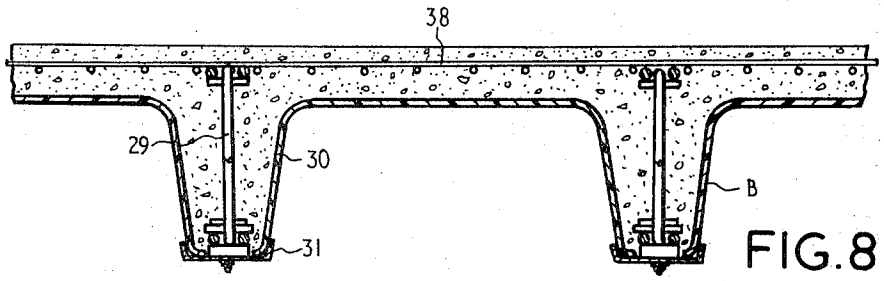

FIG.8

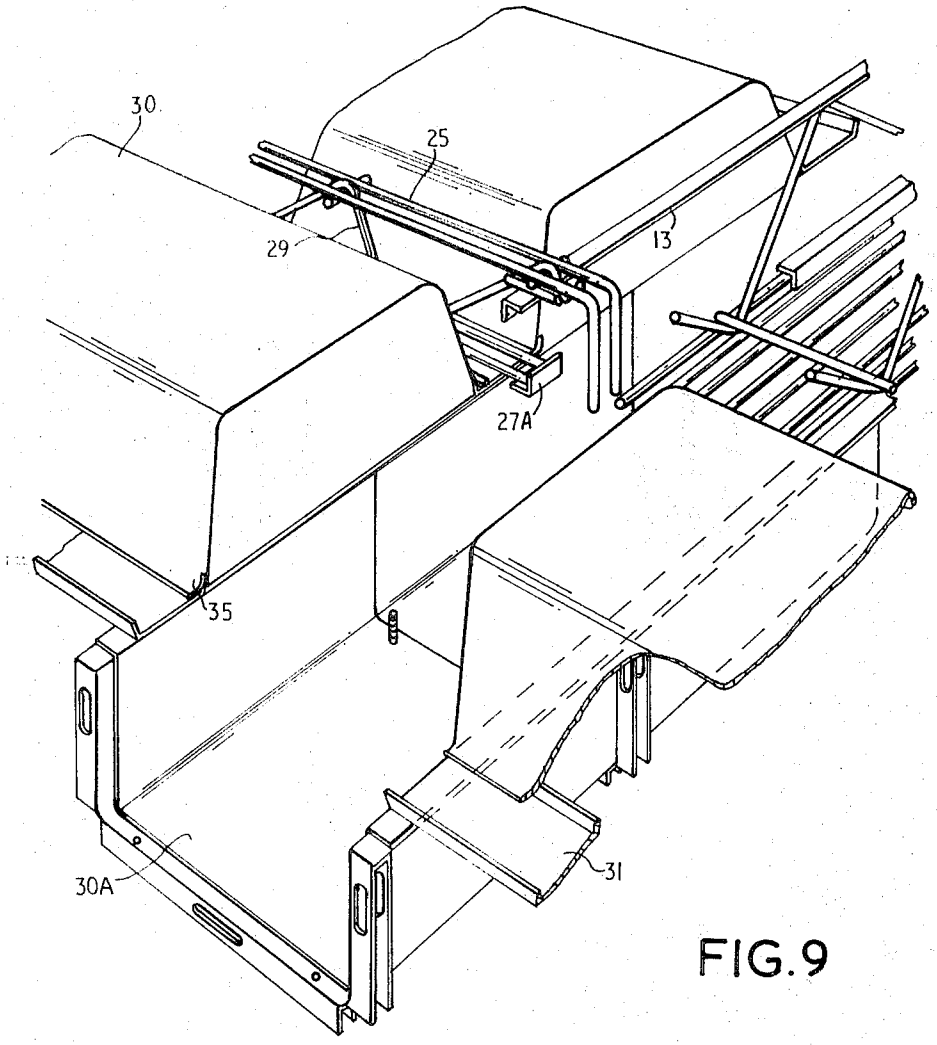

FIG.9

REINFORCED CONCRETE CONSTRUCTION

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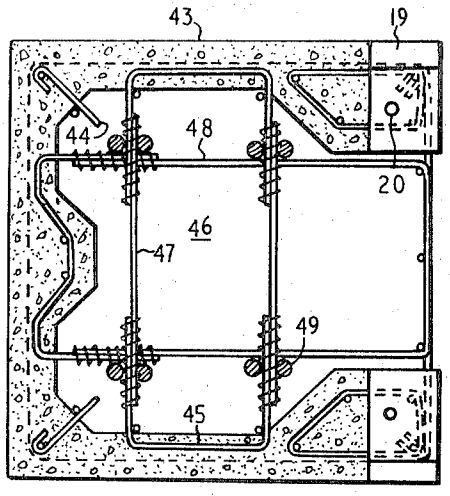

FIG. 10

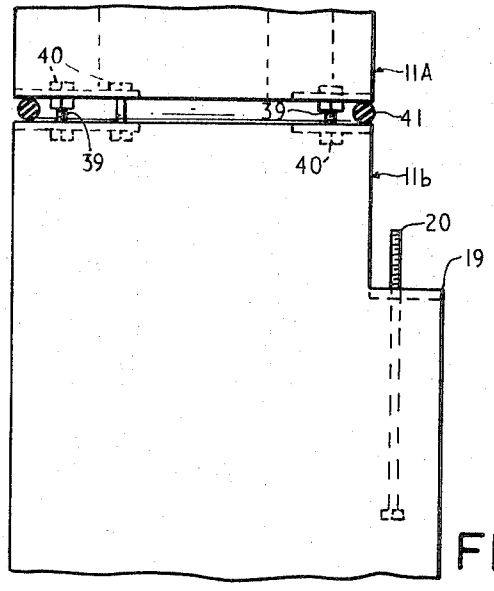

FIG. 11

United States Patent Office 3,851,024 Patented Nov. 26, 1974

3,851,024

REINFORCED CONCRETE CONSTRUCTION METHOD

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Continuation of abandoned application Ser. No. 34,975, May 6, 1970. This application Apr. 6, 1972, Ser. No. 241,517

Claims priority, application Australia, May 13, 1969, 54,893/69

Int. Cl. E04b *1/16*; E04g *21/02*

U.S. Cl. 264—34 4 Claims

ABSTRACT OF THE DISCLOSURE

A method of constructing a reinforced concrete structural member in which only sufficient active material is provided initially to carry the loads applied during some subsequent construction stages, further material is added and activated step by step to carry additional loads and at least some material acts in a final load carrying capacity from the start.

CROSS RELATED APPLICATION

This application is a continuation of our earlier application, Ser. No. 34,975, filed May 6, 1970, now abandoned, claiming priority of our Australian application, filed May 13, 1969.

This invention relates to a novel method of erecting structures.

The structural elements used in structures are those elements which are responsible for transmitting their own dead load and other imposed loads to the ground. The sum total of all structural elements is referred to as the structure. Structures are identified by the material contained in these elements and by the treatment the material receives prior to, or after its use in the structural elements.

Of the many types of structures there are those using steel and concrete in all possible combinations.

The known methods using steel and concrete either independently or in any composite manner have the disadvantage that some of the materials in the form used do not contribute their full capacity, or the components require temporary formwork and/or support, or the components are extremely heavy and require large capacity hoisting equipment, or the system of assembly inhibits speed of construction. Furthermore in no case do the known methods exploit the progressive gain in strength characteristic of concrete.

It is the objective of this invention to overcome the disadvantages of presently known methods of erecting structures and to fully exploit the progressive gain in strength characteristic of concrete.

The present invention comprises a method of building construction using reinforced concrete, which method obviates the need for temporary supporting formwork for the poured concrete, wherein use is made in the vertical and/or horizontal structural members and/or the floors, of reinforcing steel members sufficiently strong to at least support the wet concrete of the respective member or the floor, the method including the steps of placing the reinforcing steel in position, pouring the concrete to form the structural member and waiting for the progressive strengthening with time of the concrete before adding further members.

The present invention comprises a method of erecting structures which integrates the advantages of known methods using in situ reinforced concrete, where members are built up gradually into their final form by placing various materials in logical steps, in such a way that at any step members are self supporting, and contributing to their maximum capacity, including the concrete with its progressive gain in strength, generally without the need of temporary formwork and support. Specifically use is made in the vertical and/or horizontal members and/or the floor, of reinforcing steel members sufficiently strong to at least support the wet concrete of the respective member or the floor.

In one form the method includes the steps of placing the primary reinforcing steel members in position, pouring the concrete to form the primary structural member and, following its progressive strengthening with time, in the same manner positioning secondary members to the respective floor, primary members to the floor above and so on with tertiary members if required until the structure, including floors is complete.

The invention in one general form is a method of constructing a reinforced concrete structural member in which only sufficient active material is provided initially to carry the loads applied during some subsequent construction stages, further material is added and activated step by step to carry additional loads and at least some material acts in a final load carrying capacity from the start.

Some preferred forms of the invention are shown in the accompanying drawings in which:

FIG. 1 is a plan view of a typical building floor showing columns, primary beams each supported at its ends on columns and secondary joists, each supported at its ends on the beams,

FIG. 2 is a section on the line 2—2 of FIG. 1,

FIG. 3 is a section on the line 3—3 of FIG. 1,

FIG. 4 is a sectional elevation of a primary beam showing also its junction with a secondary joist,

FIG. 5 is a side elevation near one end of the primary beam,

FIG. 6 is a typical vertical section through a secondary joist,

FIG. 7 is a side elevation of portion of a secondary joist near its junction with a primary beam,

FIG. 8 is a vertical section through two adjacent secondary joists and an associated slab,

FIG. 9 is a detail in perspective of a beam and joist junction before pouring of concrete,

FIG. 10 is a typical horizontal section through a column casing and,

FIG. 11 shows a junction between two parts of a column before completion of the column.

FIGS. 1, 2 and 3 show the complete floor comprising columns, primary beams, secondary joists and a slab.

The principal components of the primary beam A shown in FIGS. 4 and 5 are a steel truss together with concrete poured around the truss. The truss shown has a top chord comprising spaced angles **13**, a bottom chord consisting of four rods **14** and rods **15** comprising the truss web. The upper chord may have cross bracing, not shown, in the horizontal plane and the lower chord may be similarly braced. Vertical cross braces **16** may also be provided. All the components are secured together as by welding into a rigid structure. Each end of each primary truss is supported on an adjacent column (FIGS. 10, 11) by means of haunches **19** on the column having upright pins **20**, each adapted to locate between the rods **14** of the primary beam. Each pin **20** extends through a hole in a plate **21** (FIG. 5) secured to the underside of each pair of rods **14**. At this stage the columns are not filled with concrete and the primary trusses are designed so that, when supported as described in their final position in the structure, they are sufficiently strong to carry

their own dead weight and all loads applied to them during the planned sequence of construction of the building. These loads would include, for example, the dead load of the joists and the live loads, for example, the weight of workmen and construction equipment. There are also located, in advance of pouring, in each primary beam reinforcing rods such as **22** and **23**, and stirrups which are not part of the truss and do not carry any load until the concrete within the beam has been poured and has developed sufficient strength to activate them.

A typical truss for a secondary joist B is shown in FIGS. 6, 7, 8 and 9. The top chord comprises two spaced parallel steel rods **25** to which are welded at intervals short rods **26**. The bottom chord comprises two similar rods **27** to which are attached at intervals short rods **28**. The web comprises a rod **29** bent at its junction with the upper chord around the rods **26** and at its junction with the lower chord around the rods **28**. Soffit forms **30**, which will usually be inverted U-section pans of plastic, sheet metal or other suitable material, extend between one secondary joist and the next. These are temporarily retained in position by means of pans **31** suspended from the truss by bolts **32** spaced along the length of the truss. Blocks **33** and **33A** spaced along the truss separate the pan **31** from the lower chord rods **27** and receive the bolts **32**. Each pan **13** is adapted to receive flanges **35** of the forms **30**.

Near the end of the joist truss adjacent to the primary trusses two short rods **36** are welded to the web **29**. The secondary truss is supported on the primary truss with the rods **36** resting on an angle **13** of the primary truss, a locating pin **37** on **13** extending upwards between the rods **36**.

If necessary, spaced abutments can be secured across the top of the rods **36** between which the pins **37** also locates. This limits or prevents endwise movement of the secondary truss in relation to the primary truss. Soffit forms **30A** (FIG. 9) similar in function to the forms **30** are suspended from the primary trusses in a way similar to the suspension of the pans **31** or in any other suitable way. An angle or end plate **27A** is secured across the ends of the rods **27**.

The design of the primary and secondary trusses is such that no props are required to support the pans **31** or the soffits **30A**.

The trusses are designed to carry their own dead weight, the concrete within them and any other loads applied to them up to the point where the concrete has set. Suitable reinforcing mesh **38** is supported on the upper chord rod **25** of the secondary trusses, initially to act as a walking surface for ready access to the slab, secondly, when tied to the upper chords of the secondary trusses to act as top chord bracing to restrain the trusses from buckling when the wet concrete is placed to the ribbed slab and finally to act as slab reinforcement when the concrete is set.

The column such as **11** (FIGS. 10 and 11) is normally a vertical or near vertical member and its primary function is to carry axial loads. In the context of most multistorey buildings the column is a vertical member, as distinct from a beam which is a horizontal member.

In conventional buildings, a concrete column is built as follows:

The reinforcing steel is placed and secured in position, the formwork is erected around the reinforcement and the concrete is poured.

The concrete in the column is given time to set and gain strength before it is loaded.

In the progressive strength system of the present invention the construction of the column follows a different procedure.

An outside shell **43** with some or all of the necessary outside final finishes is constructed in the factory. This shell is normally called the column casing. The column casing is a reinforced concrete skin with thickened parts, specially designed and reinforced to carry a specified load. The reinforcement at this stage includes conventional required components such as rods and stirrups. Some of the reinforcement such as rods **44** and stirrups **45** is set in the concrete of the casing but protrudes into the space **46** which will later be filled with concrete.

After this column casing has cured and acquired the desired strength, it is hoisted into position and the remainder of the reinforcement **47, 48, 49** for the complete column is placed inside the casing.

At this stage the column casing alone is itself a complete reinforced concrete structural element in a form adapted to be supported in its final position in the whole structure and sufficiently strong and stiff to support during construction without supports its own weight, any necessary attached formwork, the remaining part of the reinforcement for the element, the wet concrete to complete the element, and loads applied to it during construction including loads from other structural elements e.g. loads imposed by supported floors.

The tribuary loads to the column casing need not be restricted to loads imposed by one floor only. Depending on the speed of construction, the column casing might be called upon to carry loads imposed by several floors. In all cases the column casing is suitably designed to carry, on its own, or alternatively with help of some or all of the previously poured concrete in the casing which has acquired some strength, all the loads tributary to the columns to all stages of construction and loading.

The mechanism shown as screws **39** and **40** in FIG. 11 is for properly locating the lower end of an upper column part **11A** in relation to the upper end of a lower column part **11B**. When **11A** has been properly located in relation to **11B** concrete can be poured so as to fill the hollow portion of **11A** and to overflow into the space adjacent the ends **11A** and **11B**. Loss of concrete from the space is prevented by a sealing ring **41**.

The sequence of construction operations is as follows. The precast hollow concrete columns **11** are located in their final positions, both in respect of the lower most column part and the location of an upper column part such as **11A** in relation to the one below it, **11B**.

Each primary truss is supported at each end on a column haunch as described above.

Each end of each joist truss is supported on a primary truss as described before.

Mesh reinforcement such as **38** or any other suitable slab reinforcement is supported on the upper chords of the joist trusses.

The soffit forms **30A** are suspended from the primary trusses. Soffit forms **30** on the ends of the joist trusses and adjacent to the junctions with the primary trusses may also be placed in position.

Pouring of concrete can then commence.

Initially the concrete to complete the hollow columns and the primary beams is poured. When this concrete has developed sufficient strength the remaining soffit forms **30** for the secondary joists are placed in position and the joists and the slab **12** are poured.

The term "reinforced concrete" where used in the specification and claims is intended to include both conventionally reinforced concrete and also prestressed concrete.

The term "active material" means material which is able to carry load at all times and becomes part of the final structure. The trusses for the primary beams and secondary joists and the column casings are examples of "active material."

"Inactive material" is material which does not carry load until after a time lag and which then become "active" e.g. by cooperation with other material. The reinforcement of the primary and secondary beams, other than the trusses, and the wet concrete are examples of "inactive material."

In setting, the concrete bonds both the active and inactive reinforcement to provide reinforced concrete action and progressively provides additional strength as the concrete develops strength. Advantage is taken of the progressive development of strength in each element of the structure to allow the superimposing of additional vertical and horizontal elements and/or material as the required strength is attained.

What we claim is:

1. A staged method of constructing a monolithic reinforced concrete multi story structure comprising:

(1) erecting column form members in their final position,

(2) securing together a first part of the reinforcement bars of a reinforced beam as a self-contained truss adapted to be supported in final position in the completed structure, and forming the truss to be sufficiently strong and stiff to support during construction without supports other than the column form members its own weight, any necessary attached formwork, loads applied to it during construction including loads from other structural members, the remaining part of the reinforcement for each beam and the wet concrete necessary to complete each beam,

(3) placing the truss substantially at its points of support in the completed structure and supporting said truss thereat,

(4) mounting the remaining part of the reinforcement bars for the beam on the column form members,

(5) pouring the concrete to complete the column form members and engage the continuity reinforcement bars of the beam supported therefrom and provide a stable frame for immediate repetition of steps (1)–(5) inclusive at the next higher story or in another area,

(6) attaching the concrete framework to the truss of the engaged beam member,

(7) forming as in step (2), the first part of the reinforcement bars as trusses for secondary joists,

(8) supporting the reinforcement trusses for the secondary joists substantially at their points of support in the completed structure.

(9) mounting and securing any remaining parts of the reinforcement bars for said secondary joists,

(10) pouring the concrete to complete the primary beam engaged with the previously poured column form members and immediately repeating steps (6) to (10) inclusive at the next level or in another area,

(11) allowing the reinforced concrete primary framing members from steps (1)–(10) to strengthen before imposing further loads of secondary joist and/or slab member forms and concrete,

(12) completing the secondary joist and/or slab form members and pouring the concrete for the secondary joists and slab when the primary frame has gained sufficient strength, and

(13) repeating steps (11)–(12) for the next level now reaching the required strength.

2. A staged method of constructing a monolithic multi story reinforced concrete structure comprising at least one primary and at least one secondary stage, the primary stage comprising the steps of:

(1) erecting column form members in their final position and extending from one story to the next above,

(2) securing together a first part of the reinforcement bars for a reinforced concrete beam member in the form of a self-contained truss adapted to be supported in final position in the completed structure, forming said truss to be sufficiently strong and stiff to support, during construction without external supports other than the column form members, its own weight, and necessary attached formwork, loads applied to it during construction including loads from other structural members, the remaining part of the reinforcement for each member and the wet concrete to complete each beam member,

(3) placing the truss substantially at its points of support in the completed structure and supporting said truss thereat,

(4) attaching the concrete formwork for the beam member to said truss for being suspended therefrom,

(5) placing and securing any remaining part of the reinforcement,

(6) forming as in step (2) the first part of the reinforcement bars for secondary joists,

(7) supporting the reinforcement trusses for the secondary joists substantially at their points of support in the completed structure,

(8) mounting and securing any remaining parts of the reinforcement for said secondary joists,

(9) pouring the concrete to complete the column and beam member and to provide a stable work platform for immediate repetition of steps (1)–(6) inclusive at the next higher story or in a further area, the secondary stage comprising the further steps of:

(10) allowing the concrete of the column and beam member to strengthen before imposing the additional loads of joist and/or floor member forms and concrete, and

(11) assembling secondary joist and floor member forms and pouring concrete to complete the floor when the primary stage has gained sufficient strength, such completion being concurrent with steps (1)–(6) in a further area or on a higher floor level.

3. A method as claimed in claim 2 comprising pouring the concrete for the column and beam members in the primary stage in separate steps.

4. A method as claimed in claim 2 comprising pouring the concrete for the joists and slab in the secondary stage in separate steps.

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U.S. Cl. X.R.

29—155 R; 52—263, 340

UNITED STATES PATENT OFFICE
CERTIFICATE OF CORRECTION

Patent No. 3851024 Dated May 19, 1975

Inventor(s) Alan Sidney Cull and Nessib Abdallah

It is certified that error appears in the above-identified patent and that said Letters Patent are hereby corrected as shown below:

Column 5, line 48: delete "form"

after "and" insert--following sufficient strength gain--

line 49: delete "or in another area"

Signed and Sealed this

thirtieth Day of September 1975

[SEAL]

Attest:

RUTH C. MASON
Attesting Officer

C. MARSHALL DANN
Commissioner of Patents and Trademarks

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