The present invention relates to the construction of multi-storey buildings, and particularly to high buildings of ten storeys or more, although the invention is applicable to the construction of buildings with less than ten storeys.

The construction of a high building by conventional building techniques is very costly, and a long time is taken before the building is erected and finished ready for occupation or use. Tall cranes and high hoists are required; building workers are required who are experienced and capable of working at great heights; and the building has to be well towards completion of erection before the finishing trades can complete the internal finishing, installation of services and decoration.

The present invention has for its object to provide a novel multi-storey building and method of constructing multi-storey buildings which enables all the main building work to be carried out at or near ground level. Thereby the necessity for tall cranes and high hoists is avoided, and building workers only have to work at low heights. The finishing trades can also work during the erection of the building, thereby reducing the completion time.

From one aspect the invention consists in the method of constructing a multi-storey building which consists in constructing a floor at or near ground level, lifting said floor, constructing thereon at said level another floor with compression support members between the lifted floor and said another floor, said compression support members forming part of a central core structure for supporting the building, lifting said another floor with the previously erected part of the building thereon, and repeating the operation until all the floors and the central core structure are constructed, the raising operations being effected by jacks positioned to lift the already constructed part of the central core structure, and through it, the floors which project outwardly in cantilever fashion around the central core structure.

According to a feature of the invention, the central core supports at its upper end a roof which projects in cantilever fashion around the central core, the outer perimeters of the various floors being supported from the roof by means of suspension members, preferably consisting of tensioned wires or cables attached to the roof and to the floors adjacent their perimeters.

The roof may also be constructed at ground level and raised successively as each floor is constructed and raised, and a further feature of the invention consists in attaching a number of suspension wires to each floor when it is constructed and before it is raised.

The interior of the central core may be used to accommodate staircases, lift shafts, and landings, openings being provided in the core at the different floor levels to permit access to the surrounding floors.

The space between the perimeters of adjacent floors may be filled with panels or windows to enclose the floors, which may be further subdivided by partitions to form rooms.

A further feature of the invention consists in casting the floors in reinforced concrete by pouring concrete on to a base slab which forms the floor at ground level after the building has been completely erected. The centre of the ground floor slab is left open and thereon a chamber is built, supported on the base slab, in which hydraulic jacks are located for effecting the lifting after each floor has been constructed. There may also be supported from the floor of this chamber formwork on which the staircases may be simultaneously cast and tied with the main floor, this same formwork being used successively for constructing the staircases between the different floors, the staircases being lifted simultaneously with the cast floor.

A further feature consists in arranging the lifting jacks between supporting pillars, the compression-supporting wall of the central core structure being constructed of T-shaped or other interlocking blocks which may be inverted when the wall is lifted by the jacks to build downwards to form parts of the wall which will rest on the supporting pillars when the jacks are lowered.

Further features of the invention will be apparent from the following description, in conjunction with the accompanying drawings which show, by way of example, the construction of one form of multi-storey building having 20 storeys. In the drawings, FIGURES 1–8 are schematic vertical sections taken through the axis of the central core, and:

FIGURE 1 shows the foundation for the building;
FIGURE 2 shows the foundation and the cantilever roof just after it has been cast in situ on the foundation;
FIGURE 3 shows the cantilever roof and foundation just after the roof has been raised the height of one storey;
FIGURE 4 shows the foundation of a roof, and top floor just after the top floor has been built;
FIGURES 5, 6 and 7 show the building just after each of the next succeeding floors have been built;
FIGURE 8 shows the completed building;
FIGURE 9 shows in elevation part of the central core with the jacks in the lowered position;
FIGURE 10 is a view along the line A—A in FIGURE 9;
FIGURE 11 shows in vertical elevation a detail of FIGURE 9 with the jacks raised; and
FIGURE 12 shows a horizontal section through a tendon.

The stages of constructing the building are illustrated diagrammatically in the drawings. In the first stage, as shown in FIGURE 1, the foundation base a is constructed below ground level to form a jacking chamber thereon having side walls which connect with a floating ground floor slab c. The foundation base a comprises a raft constructed over a grid of piles. The ground floor slab c is cast with an appropriate thickness, for example six inches, on to a layer of hardcore and is finished off smoothly as this slab is to be used as a casting bed for all the other floors. A system of pipes opening into the upper surface of the ground floor slab c is cast into the slab and connected to an air pump. The other floors are cast on to a sheet of suitable material laid over the ground floor slab, such as a sheet of polythene, air being pumped into the pipe system in order to overcome suction when another floor is to be lifted.

Around the base of the perimeter wall of the jacking chamber are provided support pillars v having spaces therebetween within which the hydraulic jacks are located as shown in FIGURES 9 and 11.

Around the ground floor slab c a trench b is dug and paved and a retaining wall is built so that the perimeter of the ground floor slab c projects over the retaining wall. This trench b is to be used to house coils of stressing wires r used to suspend the perimeters of the floors from the roof, and to give easy access for stressing operations.

In this first stage the formwork f for supporting the shuttering for the flooring within the central core structure is also erected from the foundation base a.

In stage 2, as shown in FIGURE 2, the cantilever roof d is formed of concrete. The roof slab d is cast first on the ground floor slab c together with radial upstand
walls $d_2$ connected to the central core walls. The roof, like the ground floor slab, may be circular, square, or of other shape provided that the roof is substantially evenly balanced about the central core walls, the outer portions of the roof acting as a cantilever propped at its centre. The roof slab acts as a compression member, and the radial walls as tension and shear members. The roof of the central core acts as a tension ring. The space in the cantilever roof within the central core structure is to be used as lift machinery room, water storage tank room, fan room, etc. The suspension wires $r$ are fixed to the perimeter of the roof, the wire coils resting in the stressing trench $b$.

The central core structure $e$ which supports the building from the ground, is formed by a circular wall built of interlocking T-shaped reinforced concrete blocks $s$ (FIGURE 9) which are placed in position from underneath and constitutes compression support means between the successive floors. The central core structure is jacked up by the use of hydraulic jacks $q$ as it is constructed, as will be later described. The width of the blocks $s$ varies to increase the thickness of the wall gradually from the 20th floor downwards. Blocks adjoining lintels may incorporate projecting reinforcement rods which are cast into the concrete lintels. Releves $t$ (FIGURE 10) are provided in those blocks at floor levels to provide bearing support to the floors, and continuity of the reinforcement of the floors both inside and outside the central core is achieved by continuous steel rods $u$ (FIGURE 10) extending through holes in the blocks.

To raise the central core structure and the roof all the jacks $q$ are simultaneously actuated to lift the already constructed part of the central core structure by the height of one row of blocks $s$. Further blocks $s$ are inserted as shown in FIGURE 11 between the jacks $q$ so as to rest on the support pillars $v$. The jacks are then lowered and further blocks $s$ inserted to complete the row, whereas the jacks are again raised and another row of blocks is built.

In stage 3, as shown in FIGURE 3, the cantilever roof is jacked up to first floor level in the manner just described with reference to FIGURES 9 to 11, and the lift machinery motors $o$, water tanks, fans, etc., are installed in the rooms in the roof.

In stage 4, as shown in FIGURE 4, the 20th floor $h$ is cast on to the ground floor slab $c$. The stairs $j$ and landings within the central core structure $e$ are also cast on a specially designed permanent formwork $f$ which is propped up within the jacking chamber. The 18th floor walls $m$ and other walls within the central core structure are built. Pre-cast concrete casing $g$ for the suspension wires $r$ are placed in position. These casings form a cavity (see FIGURE 12) through which one of the groups of wires $r$ disposed around the perimeter of the roof passes downwards. For a 20 storey building there are preferably 21 wires in each group, that being one wire for supporting each floor $h$, with a spare wire in case of need. Conveniently wires such as used in conventional pre-stressing systems may be used. In this fourth stage one wire of each group is stressed by conventional stressing jacks accommodated in the stressing trench $b$ and is secured by appropriate anchoring means. The external cladding walls $k$ are erected between the 20th floor and the roof and the windows and window panels $i$ fixed. A light weight walling material may be used for the cladding $k$.

In stage 5, as shown in FIGURE 5, the 20th floor is raised to first floor level by the jacks lifting the blocks of the central core structure as above described. Two-floor high scaffolding $i$ is erected around the building where required so that the external walls on the erected 20th floor can be finished and the windows glazed. On the ground floor slab $c$ the 19th floor $h$ is cast together with a further section of staircase $j$ and the casings $g$ and external walls $k$ fitted as described for stage 4 and one further stressing wire $r$ of each group is stressed and anchored to support the 19th floor. The lift cabin $p$ is installed and the installation of partitions and joinery can be undertaken on the 20th floor.

In stage 6, as shown in FIGURE 6, the 19th floor is raised by the jacks as described to first floor level, the 18th floor and staircase is cast on the ground floor slab $c$, the casings $g$ and external walls are fitted, and a further suspension wire of each group is tensioned as above described. The workers erecting partitions and joinery move down to the 19th floor whilst the specialist trades installing services can work on the 20th floor.

In stage 7, as shown in FIGURE 7, the 18th floor is raised by the jacks as above described to the first floor level and the sequence of building operations repeated, partitions and joinery being erected in the 18th floor; specialist trades operating in the 19th floor and finishing trades in the 20th floor. The erection proceeds in like manner until the building is completely erected as shown in FIGURE 8. At this stage the jacks $q$ are removed from the spaces between the jacking support pillars $v$ and these spaces are filled in with concrete to provide full bearing for the central core $e$, the casings $g$ are grouted up, and the stressing trench $b$ filled in. It will be noted that the finishing trades have been working downwards from floor to floor as the building is erected so that they have never had to work above the height of third floor level.

The lift shaft $m$ is built as the erection progresses and the lift guide rails are installed and plumbed downwards during the construction of the building.

With the method described a permanent base mould is provided for each floor constructed, this base mould consisting of the ground floor slab $c$ and the permanent formwork $f$. This formwork is only removed after the building is completed, leaving the jacking chamber clear to form a basement.

The method of construction according to the invention enables the completion time to be considerably reduced. All the heavy building work is carried out at ground floor level, most of the workmen do not have to work above the third floor level; all except the last three floors can be finished by the time the building construction is completed and there is no further delay occasioned by having to install lifts after erection since this takes place during erection.

Whilst a particular embodiment has been described, it will be understood that various modifications may be made without departing from the scope of the invention. For example, the central core structure may be constructed in other ways, such as by concrete cast in situ or by a structural steel framework. Furthermore, each floor may be cantilevered out of the central core thus saving the use of any columns, tendons or the like. The method may also be applied to constructing other kinds of buildings, such as garages in which each floor is in the form of a helical ramp up which the cars may be driven. In this case external cladding of the building may not be necessary; the perimeters of the floor need only be protected by low walls or railings.

I claim:

1. The method of constructing a multi-storey building comprising the steps of constructing at or near ground level a floor cantilevered to a central core portion, raising said floor to the height of one storey by jacking up said central core portion in a succession of steps less than the height of a storey while building the step by step as said central core portion is raised an additional central core portion beneath and supportingly joined to said first mentioned central core portion, constructing at or near ground level an additional floor cantilevered to said additional central core portion, raising said additional floor in the same manner as in the building of the building by like manner to construct and raise central core portions and floors until the building has reached the desired
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height, said floors being supported at least primarily by said core portions as they are being raised.

2. The method claimed in claim 1 according to which said core is made of horizontal rows of interlocking blocks, with alternate blocks in each row having portions which extend beneath and support portions of the remaining blocks in said row, while said remaining blocks in said row support the row immediately thereabove, pillars are supportingly positioned beneath said remaining blocks of the lowest completed row, the completed floors are then raised in a step equal to the height of a block by means of jacks acting on said alternate blocks of the lowest completed row, said remaining blocks of the next row to be completed are then positioned on said pillars to support the remaining blocks of said lowest completed row, after which said jacks are lowered and the alternate blocks of said next row inserted thereabove to complete said next row, said steps being repeated until the complete floors have been raised the height of a floor so that a new floor may be constructed at ground level.

3. The method claimed in claim 2, which further consists in supporting at the upper end of the central core a roof which projects in cantilever fashion all around the core, and supporting the outer perimeters of the floors from the roof by means of suspension members attached to the roof and to the floors adjacent their perimeters.

4. The method claimed in claim 3, which further consists in constructing the roof at ground level, raising it successively as each floor is constructed and raised, and connecting the suspension members from the roof to each floor adjacent its perimeter before it is raised.

5. The method claimed in claim 3, which further consists in supporting the perimeters of the floors from the roof by means of high tensile wire, the wires being arranged in groups around the perimeter, each group comprising a separate wire for supporting each floor, enclosing each group of wires in casings extending between adjacent floors, pre-stressing each wire before it is attached to a floor, and filling the casings with concrete grout or the like.

6. The method claimed in claim 1, which further consists in constructing the floors on a base slab which forms the floor at ground level after the building has been erected, constructing a chamber, supported on foundations, beneath a central opening in said base slab, constructing compression support means in said chamber, and raising the compression support means and the floors constructed on said base slab by means of jacks located in said chamber.

7. The method claimed in claim 6, which further consists in casting staircases of concrete within the central core structure by pouring concrete on to the formwork carried from the floor of said chamber, each staircase section being raised simultaneously with its associated floor.

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