A LOAD-BEARING HORIZONTAL STRUCTURAL SYSTEM FOR A BUILDING.

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Description

The invention relates to a load-bearing horizontal structural system for a building, the system consisting of loadbearing slabs or slab-like structures which constitute the frame of the said horizontal structure, and of support parts which transfer loads from these slabs to the loadbearing vertical frame and extend in the horizontal direction from the cross sectional surface of any given vertical frame to the area of the slab. Uses for this horizontal structural system include intermediate floors, roofs and base floors of buildings.

The load-bearing horizontal structures of a building constitute a major part of the frame of the building and thus of the costs of the frame. The load-bearing horizontal structures are in general implemented by using massive slab systems, slab-beam combinations, such as the conventional downstand beam or upstand beam systems or the structure depicted in publication DE 2 350 437, or by using lightweight slab systems (hollow-core slab, ribbed slab, waffle slab, etc.). The conventional, and the most common, method of supporting the slab system is to build it on top of columns, walls, beams, or the like. Also downstand extension and reinforcement (so-called mushroom structure) is used in a mushroom slab structure, as in the conventional mushroom slab cast in situ or in the structure disclosed in publication GB-1 079 751, or reinforcement included in the slab thickness is used, as in publication DE-2 221 549, in order that the slab system at a moderate thickness should withstand loads without shearing at the pillar.

With the increase in pipe, electrical and other such installations in buildings, considerable difficulties have appeared in particular in the arrangement of load-bearing horizontal structures and installation roads. To minimize storey height, as small an intermediate-floor thickness as possible must be aimed at. Installations under load-bearing beam systems result in great floor thickness, and installations at the level of load-bearing beam systems result in problematic structures and unnecessary criss-crossing of installations. When an embedment floor is used, electrical and other wiring is usually located below it and the HEPAC installations are located between the load-bearing slab and a suspended ceiling, in which case the total thickness of the intermediate floor will be great. Structures and installations below the slab complicate the rational constructing or installing of adjoining components, such as partition walls, fixtures, other installations, etc. In a twin-floor structure in which the lower component constitutes the load-bearing lower slab, the upper beams, trestles or other structures constitute obstacles to installation roads and installation, at least in one direction, but often also in all directions. A raised floor will often also be high and heavy.

It is therefore an object of the invention to provide a load-bearing horizontal structural system for a building, a structure which enables the other systems of the building, such as piping, wiring and other installations, to be installed in all horizontal directions without being hampered by the load-bearing structures. The second object of the invention is to provide a horizontal structural system such as this, with as small as possible a structural height. The third object of the invention is to provide a horizontal structural system such as this, making it possible to increase its support span or correspondingly to reduce the structural thickness of the floor as compared with those currently used, and to use the structural height effectively, both structurally and for installations. The fourth object of the invention is to provide a horizontal structural system such as this, which can be implemented either as a structure made in situ or as a prefabricated-component structure, is easy and rapid to implement, and makes it possible to produce structural entities of a plurality of different shapes. The fifth object of the invention is to provide a horizontal structural system such as this, which makes it possible to alter the installations easily at a later date, in which case the alteration work will focus only on the area to be altered. The sixth object of the invention is to provide a horizontal structural system such as this, in which the structural parts which transfer loads of the load-bearing slab to the vertical frame of the building are not visible, but all the visible surfaces are substantially smooth, in which case all the spaces between the load-bearing vertical structures are entirely in their full height available for use for other purposes. It is a further object of the invention to provide a horizontal structural system which is not restricted to any building material; thus the material may be reinforced concrete, a prestressed structure, a steel structure, a wooden structure, a composite structure, or some combined structure.

The said objects are accomplished and a crucial improvement regarding the disadvantages described above is achieved by means of the system according to the invention. To achieve this, the invention is characterized by what is disclosed in the characterizing clause of Claim 1. Preferred embodiments of the system are presented in the dependent claims.

It can be regarded as the most important advantage of the invention that, for example, compared with the reinforced concrete mushroom slab structure generally used, an approximately 50 % saving can be achieved in the consumption of both concrete and steel, since the effective span length of the slab portion is substantially reduced. In addition, the system according to the invention makes it possible to install pipes and wiring, etc., between the formed twin structure in all directions without obstacle, and in this case alteration of the installations is also possible by focusing the alteration work only on the desired area,
since the embedment floor can be easily removed and does not affect the structural strength. It is a further advantage of the invention that it can be easily implemented as a prefabricated-component structure, and especially a prefabricated-component structure in which the joints between similar or mutually different components are easy to make. The completed structure will thus be relatively lightweight and easy to produce, both of these factors decreasing the costs.

The invention is described below in greater detail with reference to the accompanying drawings.

Figure 1 depicts a schematic plan view of the horizontal structural system according to the invention, sub-figures 1A-1D depicting different methods of implementing the support part, Figure 2 depicts a side view of the structure shown in Figure 1C, Figure 3 is a more detailed axonometric representation of the embodiment of Figure 1A, Figure 4A depicts a plan view of the embodiment of Figures 1A and 3 at the stage of the making of the embedment floor, Figure 4B depicts the embodiment of Figure 1B, slightly modified, at the stage of the installation of the embedment floor, Figure 5 depicts a side view of the embodiment of Figure 4A, with examples of the embedment floor and installation, Figure 6A depicts one embodiment according to Figure 1B, Figure 6B depicts a side view of the embodiment of Figure 4B, Figure 7 is an axonometric representation of the embodiment of Figure 1C, as a prestressed construction, Figure 8 depicts a plan view of the embodiment of Figure 7, slightly modified, Figure 9 depicts a side view of the embodiment of Figure 8, Figure 10 depicts a modification used in connection with the embodiment of Figure 1C, Figure 11 depicts the horizontal structural system according to the invention, as a prefabricated-component structure, as an example of the design of the component, Figure 12 depicts a number of different designs of the horizontal component, usable in the horizontal structural system according to the invention, Figure 13 depicts one variant of the component design in a horizontal structural system implemented using prefabricated components, Figure 14 depicts schematically a horizontal structure obtained using another component design, Figure 15 depicts in greater detail the component structure of Figure 11, applying the support-part arrangement of Figure 1C, Figures 16 and 17 depict side views of the structure of Figure 15 at the pillar, depicting certain methods of jointing a basic component according to the invention and an additional component, Figures 18 and 19 depict two other methods of jointing a basic component and an additional component, Figures 20-22 depict a number of different possibilities of connecting a support part and a basic component, Figure 23A-C depicts different designs of the joint situated in the basic component but belonging to the support part, Figure 24 depicts the steps of one method of making the joint between basic components or between a basic component and a support component, Figure 25 depicts a plan view of a connecting joint between two basic components, or respectively between a basic component and an additional component, according to one method of making the joint, Figure 26 depicts the connecting joint of Figure 25 in the horizontal direction, Figure 27 depicts one other cross sectional shape of the basic component and the additional component, and their jointing method.

Primarily an intermediate-floor structure is discussed below with reference to the above-mentioned figures, since it is in an intermediate floor that the advantages and properties of the invention are best manifested. The invention is by no means limited to this application.

The intermediate-floor structure is a twin-layer structure which is made up of a load-bearing lower slab structure 1, usually serving as the ceiling of the lower space, an embedment floor 2, and a "mushroom-like" support part 4 built in the space 3 left between the slab structure and the embedment floor and located above the horizontal slab 1 and supporting it. The horizontal slab 1 and the embedment floor 2 constitute one horizontal structure of the building, the structure thus not being necessarily precisely horizontal, although that is usual; it can be moderately tilted from the horizontal plane but deviates crucially from the vertical or nearly vertical frame 5. Support parts 4 connect the horizontal slab 1 to the vertical members of the frame 5 of the building, for example to pillars 6. Figures 1A and 3, as well as 4A and 5, show support parts according to the invention which have been, for example, cast from concrete. The support part 4 has been cast either as one piece with the bearing vertical pillar 6 of the building frame, or they have been interconnected in a manner not shown, in which case the support part may constitute a vertical continuation part of the pillar or the respective wall. The support part 4 is in this example made
up of four branches 7a-d of the type of a cantilever beam, the branches extending to a considerable distance from the vertical pillar 6 as compared with the transverse dimensions of the pillar. The load-bearing horizontal slab 1 is fastened to the lower surface 11 of the branches 7 of this support part 4, either over the entire surface or over part of it, to support the slab. This fastening is implemented specifically in the area of the ends 8a-d of the branches 7 or in their vicinity, for example by connecting within the branches of the concrete support part by means of parts 9a-d possibly belonging to its reinforcement, or by other methods known per se. In the support parts 4 the direction of the greatest strength of the reinforcement of the concrete is often oriented according to the main load, i.e. in the branches 7 the reinforcements are oriented from the vicinity of the pillar 6 on the upper surface 10 of the support part in the vicinity of its ends 8a-d to the lower surface 11 of the support part, where they join the fastening points of the lower slab 1. The branch 7 may, of course, also have conventional concrete reinforcement, not shown in the figure, instead of parts 9. Depending on the method of construction, the reinforcement of this branch may be connected to the slab 1, or the branch 7 may be connected to the slab in some other manner.

In this manner, the effective support span of the slab 1 is reduced from the real distance D1 between the pillars to a value D2, which is the distance between the outermost support points of the branches of the support part 4, i.e. between their ends 8a-d. In this case it is, of course, possible to make the horizontal slab 1 considerably lighter in weight and thus less expensive than previously. The space between the horizontal slab 1 and the embedment floor 2 is now practically entirely free for the installation of pipes 12 or corresponding lines. The restrictions imposed by the support part can be reduced even more by forming in it throughholes 13 in points not essential in terms of the loading direction. The support part 4 can in this embodiment also be used for supporting the embedment floor 2, as shown in Figures 3, 4A and 5. It is especially advantageous to arrange the support to take place within the area of the ends 8a-d of the cantilever beams or cantilever trestle beams, in which case the embedment floor can be made self-bearing at these points owing to the reduced support span, as shown in Figures 3, 4 and 5.

The support part 4 can also be made of concrete as a more massive, mushroom-like piece or as a prefabricated component, as shown in Figure 1D. Figure 1B, for its part, shows a structure otherwise corresponding to Figure 1A, but in it the branches 7a-d of the support part are formed from, for example, steel, which may be, for example, an I-beam in the cross section of the branches, as shown from the side in Figure 6A, or a trestle or some other known steel profile. The fastening of the support part 4, shown in Figure 6A, to the horizontal slab 1 by means of members 14 extending downwards from the beam branches 7 and broadened at their lower ends, or similar members formed from sheet metal is well applicable to, for example, casting in situ. In this case, also, it is possible to make throughputs in the support part branches, in the waist of the I-beam.

Figures 1C, 2 and 7-9 depict a very simple and versatile support arrangement. In this the support part branches 7a-d are made of steel bars, steel cables or the like, extending in pairs from the vicinity of the outer surface of the support pillar 6 in opposite directions down to the horizontal slab 1, all of them being called tension bars 15 in this application. The tension bars 15 are suspended from the load-bearing vertical pillar 6 either to bear on pins 17, as shown in Figure 7, or to bear on notches 18 provided in the pillar 6, as shown in Figures 8 and 9, or in some other manner, not shown here. The tension bars 15 extend radially from the pillar 6 to inside the horizontal slab 1, where they attach to the horizontal slab in a manner appropriate in each given case. In this structure, also, the effective span between the pillars 6 decreases from the value D1 to D2, which is approximately the distance between the connection points 19 of the bars 15 and the horizontal slab 1. In this case, the implementation of installations is especially flexible, since they can be made almost without obstacle in the area of the tension bars 15 close to a pillar or the like. In this case it is advantageous to support the embedment floor 2 so as to bear on separate supports in the area of the connection points 19, in which case the embedment floor can be made self-bearing, as described above in connection with the cantilever beam alternative.

The support system according to the invention for the slab 1, implemented in this manner using tension bars 15, is especially advantageous in the sense that in that case the bars in question can be used for the preliminary raising and pre-tensioning of the slab and for the tightening of the tension bars, as well as, if the slab is a prefabricated component, for the adjustment of the height of the slab 1. This can be carried out, for example, by pressing in each pair of bars two adjacent bars 15 towards each other, for example at point 20 by means of a tightening means 21 not shown in greater detail. In this alternative the necessary fire protection of the bars 15 is implemented by coating the bars 15 in a suitable manner and with a suitable material or by covering the surroundings of the bars with a concrete mix or the like 22, as shown in Figure 9.

Figures 4B and 6B depict, as one alternative according to the invention, a combination of the systems according to Figures 1A, 4A, 5 and Figures 1C, 7-9, in which the branches 7a-d are formed towards the center, i.e. closer to the pillar 6, of concrete, for example, as in Figure 3, but from the upper edge 10 of the outer surface 8a-d of these concrete branches
there extend obliquely downwards to the horizontal slab 1 support bars or cables or the like 23. In this case the support span of the slab 1 must be measured from point 24, which is at the meeting point of the said bar 23 and the horizontal slab 1. The bar 15 or 23 can further be continued beyond the meeting point 19 or respectively 24 half-way between the pillars to below the slab 1, as shown in Figure 10. In this case there will be no actual fastening point for the bar 15 or 23 and the horizontal slab 1, but the member bearing the load will extend over the entire dimension of the slab. Likewise, the bar 23 may continue along the upper surface 10 of the branch 7 as far as the pillar 6 or beyond it. Thus the entire horizontal slab can be brought to bear on a continuous "supporting network." This method is usable especially in repair construction for increasing the load-bearing capacity of old horizontal structures.

The shape and structure of an upstand support part 4 is, of course, not limited to the examples described above but can be formed in any manner, taking into consideration that it supports the load-bearing slab 1 below it. In other words, the slab 1 is suspended to bear partly or entirely on the support part. In the cases depicted in Figures 3, 4A, 4B and 5, the base slab may be dimensioned for carrying only its own weight, the installation load, and the other direct loads bearing on the base slab. The live load on an intermediate floor is supported and transferred to the horizontal slab by means of an embedment-floor structure which, having a short span, can thus be implemented economically, as described later in this application.

In the above, the support part is described as having four branches, but according to the use involved, the branches 7 may number one, two, three, four, or more. The branches may be mutually symmetrical and protrude at regular angular distances, or they may be asymmetrical in location and/or in length. It is, however, advantageous to orient the branches 7 either in parallel to the pillar network or in particular obliquely to it, for example in parallel to the diagonal of the pillar network, as in Figure 1, or nearly diagonally, as in Figure 15. In the vicinity of the side walls the branches 7 can also be oriented diagonally, as in Figure 1, or in parallel to the wall, as in Figure 15, or in some other manner. The load-bearing vertical structures of the building may also be located asymmetrically.

Figure 11 depicts one intermediate floor formed as a prefabricated-component structure by using the horizontal structural system according to the invention. This structure is made of vertical pillars 6 and of basic components 25 suspended to bear on them through a support part according to the invention, not shown in this figure, since it can be of any embodiment, and of slab-like additional components 26 or other supplementary structures further disposed to bear on these basic components, whereby a horizontal structure 1 is formed. In the invention the slab component is in general located centrally on the pillar line, whereas in known prefabricated-component systems the joint between the slab components is in general on the pillar line. The component according to the invention can, when so desired, also be divided into two parts the joint of which is on the pillar line. Likewise, of the half-slabs only one can be used alone, for example, on the facade side. The support of the component can be implemented not only, in the manner described, to bear on pillars but also to bear on walls or other load-bearing structures.

Figure 12 depicts different shapes of the basic components. The most advantageous of these is in general the hexagonal component depicted in point 12a, which, for example when installed in the space between pillars enables similar load-bearing components to be placed systematically in two directions in the spaces between the pillars, as shown in Figures 11 and 13. When necessary, an empty space left between components can be filled in with components bearing on the said load-bearing basic components, for example using simple lightweight slab components 25 or by using other conventional construction methods, or openings, skylights, etc., between the storeys can be made in this intermediate space.

When a hexagonal basic component 25 is used, it is possible to accomplish, by using one component type and a simple supplementary additional component, a clear structural system, capable of being implemented using only a few component types and making possible a smooth ceiling surface when, for example, the joint 40, 41 of the basic component and the additional component, according to Figures 16 and 17, is used. By making variants of the hexagonal basic component (Figure 12a) by enlarging and/or reducing the slab portion of the component, a desirable flexibility usually lacking in prefabricated-component systems is obtained in the said prefabricated component system for multiform construction. A simple variant of the component is a rectangular component (Figure 12b) or a component made perpendicular at only one end (Figure 12b). With the help of the former, a simple horizontal structure 1 is obtained by using parallel basic slabs and supplementary additional slabs. With the help of the latter (Figure 12d), in the basic structural alternative a conventional straight facade can well be implemented, as shown in Figure 11. The variants of the basic component can be implemented advantageously especially when their support is arranged in the area of the horizontal surface of the basic component. In this case the enlarging of the component is possible to a moderate degree also as a slab cantilever. In practice the modified component can be easily manufactured in a component factory, when the size of the form table, battery form, or other formwork system is
selected to have the shape of a rectangle of the dimensions of the basic component (Figure 12d), or preferably one of the forms is selected to be longer in case of possible cantilevers extending beyond the pillar (for example Figure 12h or 12k). By shifting the edges of the forms according to need and by installing additional reinforcements in the slab portion of the component, variants are obtained simply and at moderate cost. The shaping can also be carried out by sawing the components from a piece implemented by continuous casting or by some other known method. By making the component ends round or into some other desired shape, highly imaginative shapes can be obtained for buildings. Thus, through combination of basic components 25 and their variants, as well as additional components 26, an almost unlimited number of different types of buildings can be constructed with only slight practical problems, and thus, as for example in Figures 13 and 14, it is possible to respond to a challenge to which prefabricated-component systems in general are unable to respond.

Figure 15 depicts an advantageous method according to the invention for suspending basic components 25 from pillars 6 by using bars 15. In this case it is especially advantageous to introduce the slabs in the spiral points 19, for example, within the pillar-less corner areas 27 of the hexagonal basic component, for example at an angle of 45 degrees in relation to the slab's longitudinal axis, which is often the same as the pillar line. Thus the effective spans of the horizontal slab 1 consisting of the basic and additional components can be reduced advantageously, as described above. The bars 15 or other support parts may, of course, be parallel to the longitudinal direction of the basic component or perpendicular to it, as in point 28 next to a straight facade, or at some other angle.

A suspension angle at an angle of 45 degrees to the longitudinal axis P of the slab is well suited for a hexagonal basic component type and enables variants of the slab to be made advantageously. At both ends of the basic component there are typically, for example, two suspension structures 15.1 and 15.3, 15.4 and 15.5, 15.6 and 15.7, 15.8 and 15.2. When basic components 25a, 25b, 25c, 25d are installed in both orientations, the adjacent suspension structures of the adjacent components 25a and 25b, 25b and 25c, 25c and 25d, 25d and 25a constitute one support part 4 for the final slab system. When the branches of the support part 4, formed of the tension bars 15, are in the above-mentioned manner at an angle of 45 degrees, the tension bars in pairs will be continuations of each other, 15.2+15.1 and 15.5+15.6, 15.3+15.4 and 15.7+15.8, either straight, as at point 42 in Figure 15, or crossed, as at point 43 in Figure 15. Thus the various parts of the support parts of different components form the continuous support part 4 in the completed structure. The structure described has the further advantage that at the point in question the branches of the support part draw the basic components 25a, 25b, 25c, 25d towards one another and towards the upright pillar 6 in question, whereby the joints 44a, 44b, 44c, 44d between the components remain tightly closed. When variants of the basic-component slab are used, the component-specific suspension structures are shifted and/or increased according to need (for example, Figure 12h or 12k). For example, when cantilever slabs are used, suspension structures can be placed also in the cantilever.

The basic component can be made lighter outside the support part 4, for example, by means of openings 29 or thinnings 48, as shown in Figures 21 and 22, or in the area of the pillar 6 or some corresponding part of the vertical frame, in which case the horizontal component and the horizontal slab will become a freely suspended structure bearing on the support part. Suspension cables, bars, trestles, rib structures or other support parts 4 according to the invention, or their fastening points 30, can be made fully ready in the prefabricated components, or the components may be provided with the necessary fastening parts, as shown in Figures 22 and 23a-c, for suspension taking place on site. In the case of suspension supports ready made in the component, the tightening/tensioning of the suspensions can be carried out, when necessary, by means of tightening adjusters such as bolts, nuts or clamping sleeves or by tightening or tensioning the bars to one side, downwards or upwards, as described earlier, or by other methods known per se. A support part installed in a component may also constitute only part of the final suspension support, in which case the tightening or tensioning part may, when necessary, be installed on site. Suspension support can be implemented in a manner advantageous in terms of prefabrication, for example, by installing in the component, with sufficient bonding, for example flat-welded bolts, gripping bars, a perforated or other such gripping profile, or by installing by other methods known per se, a fastening flange 30, an angle bar or some other known fastening part, or a notch, groove or similar recess, or a pin 31, hook or other such-like for purposes of fastening and/or suspending. In the flange, angle bar or corresponding fastening part there is made a hole, fastened a bolt, pin, hook, perforated sheet, a fastening part with a thread or a sleeve, or other such fastening part for fastening the suspension support 4. The fastening part may, when necessary, serve at the same time as a hoisting hook during transport or installation of the component. The suspension fastening made in the component may also be a round bar, ribbed bar, flat bar or some other kind of bar, for example a cable which is provided with anchoring steels or other anchoring parts and is cast into the component. The suspension part 4 may be provided with extension and/or tightening members 21.

In a joint 36, 44 between basic components, in a
joint 40, 41 between a basic component and an additional component, and/or in a joint between additional components, the components may be fastened to one other in such a manner that the joint will serve as an articulation or in a torque-rigid manner. The fastening and stiffening can be effected by welding the steel fasteners in the joint area to each other by using, when necessary, a flat bar or some other additional bar. The stiffening can also be effected by making in the components a tubular recess 32, 33, in which there is installed a steel tube or steel bar 34 which during the installation of the components is in the groove 33 of one component 25 and is pushed after the installation of the components to extend into the groove 32 of the other so that it will couple, for example, components 25a and 25b to each other. This joint is, when necessary, stiffened by casting or injecting with a mix 45 which fills any remaining gaps. The stiffening can also be carried out by bolting, by grouting by using the recesses made in the components, reinforcement bars installed in the components and, when necessary, additional reinforcement bars and/or a fiber-reinforced concrete mix, or by other methods known per se.

One method of stiffening prefabricated-component structures is to make in the component a dovetail or other recess 35 by using, for example a metal-sheet or other casing 46 which is provided with the necessary bars 47 which provide bond and prevent cracking. The recess may also be a steel part or a bolt notch. By installing, in the recesses 35 located opposite each other in this component joint 36 to be stiffened, bolt-like reinforcements 37 thickened at both ends or otherwise provided to obtain sufficient bonding, when necessary together with grouting 38, a joint which will withstand tension, shear and/or torque is obtained between the components. Bolt-like or similar jointing parts can also be assembled into prefabricated "joint ladders" 39 to facilitate installation work.

The slab component may also be part of the final slab structure. In this case, for example, the slab system may be made by casting a strengthening and/or stiffening in-situ layer with possible additional reinforcement bars on top of the components, which will at the same time act as a mold and possibly constitute part of the reinforcement, or the whole reinforcement. In this case the intermediate-floor structure may or may not contain an embedment floor structure.

The additional components supplementing the basic components may be relatively lightweight massive slabs, lightweight slabs such as hollow-core slabs, or other slab-like structures known per se. Figures 16 and 17 depict two different ways of connecting an additional component 26 to the basic component 25 by means of a joint 40 and respectively 41. By using these solutions a smooth ceiling surface is obtained for the lower storey, and the largest possible space 3 is obtained between the embedment floor 2 of the upper storey and the horizontal slab 1. In the event that a smooth ceiling surface is not desirable or necessary, the additional component 26 may also be placed on top of the basic component 25, as shown in Figures 18 and 19. In this case, however, not only a smooth ceiling but also an embedment space inside the intermediate floor is lost. It is also possible to combine a structure which makes possible conventional downstand installation with the structure according to the present invention by using an additional component 49, depicted in Figure 27, in which the embedment space 3 is below, which has both advantages and disadvantages.

The structure of the embedment floor 2 may be of any type known per se, but preferably of a type which has an adjustable height, can be detached in parts, and is provided with recesses for pipes, cables and other installations. It is also possible, when so desired, to embed in the basic component and/or the additional component pipes or cables or the like and/or throughputs or recesses for them. A further possibility is to make base-floor and intermediate-floor components from the horizontal slab 1 or part of it, for example a basic component 25 and/or an additional component 26, and from the embedment floor 2, such base-floor or intermediate-floor components containing both the slab 1 and the embedment floor 2, as well as the support part 4, as well as to make roof components equipped with a roof structure corresponding to the embedment floor 2. Thus a high degree of prefabrication is achieved while all the advantages of the invention are gained.

Regarding the variants it can be noted that, especially in the case of a roof, the horizontal slab 1 may also be at an angle, for example the angle of slope of the roof, in relation to the horizontal plane. Likewise, the structural material of the slabs and the support part may be of any material or any combination of materials otherwise suitable for the purpose.

Claims

1. A load-bearing horizontal structural system for a building, comprising load-bearing slabs (1) of slab-like structure which constitute the frame of the said horizontal structure and support parts (4) which transfer loads from these slabs to the load-bearing vertical members (6) of the building frame (5) and extend in the horizontal direction from the cross section of any given vertical member (6) to the area of the slab, characterized in that the load-bearing, mainly horizontal slabs (1) are substantially thinner than the final visible structural thickness of the intermediate floor, roof and base floor of the building, that the support part (4) extending from any given vertical member (6) of the building frame (5) in the horizontal
direction or a slight angle to the slab (1) is above the slab and is fastened to it at least at one point, which is at a horizontal distance from the vertical member in question, to support the slab (1) from outside the vertical member (6), and that the support part (4) at least in the main is contained in the visible horizontal structure of the building.

2. A horizontal structure system according to Claim 1, characterized in that the horizontal slab (1) constituting the frame of an intermediate floor, roof or base floor consist of basic components (25) bearing directly on the said support part (4) and, when necessary, of additional components (26) placed between these basic components and bearing on them.

3. A horizontal structural system according to Claim 1 or 2, characterized in that the support part (4) consists of one or several cantilever beams or cantilever trestles (7), which extend at angular distances away from said vertical member (6) in a plane approximately perpendicular to it, and are by their lower surface (11) or part of it fastened to the horizontal slab (1) to support the slab.

4. A horizontal structural system according to Claim 1 or 2, characterized in that the support part (4) consists of one or several separate tension bars or the like (15) which extend separately or in groups at horizontal angular distances away from said vertical member (6) obliquely downwards to the horizontal slab (1), and which are fastened both to the vertical-frame part in question and to the horizontal slab in question to support the slab.

5. A horizontal structural system according to Claim 3 or 4, characterized in that the support part (4) is made as a combination of tension bars (9, 15, 23) and cantilever beams or cantilever trestles (7), the tension bars running inside the cantilever beams in the approximate direction of the load, from the beam's upper surface (10) close to a vertical member to the beam's lower surface (11) close to its outer end (8), or alternatively on the continuation of the cantilever beams from their upper surface (10) down towards the horizontal slab (1).

6. A horizontal structural system according to any of the above claims, characterized in that the horizontal slab (1) or the basic component (25) constitutes the structural portion of the support part (4) and that the support part is connected either to the horizontal slab in connection with in situ casting or to the basic component in connection with the casting of the prefabricated component.

7. A horizontal structural system according to any of the above claims, characterized in that the horizontal slab (1) or the basic component (25) or the support part (4) at the same time constitutes a vertical continuation part of the component pillar (6) or the corresponding wall.

8. A horizontal structural system according to any of the above claims, characterized in that the said cantilever beams (7) and/or tension bars (15, 23) or other corresponding support parts (4) are in their entirety between the horizontal slab (1) and the embedment floor (2) built on top of the slab, and that the space (3) between the horizontal slab and the embedment floor is available for use as an embedment space for installations.

9. A horizontal structural system according to any of the above claims, characterized in that the cantilever beams (7), tension bars (15, 23) or tension bar groups or corresponding load-bearing parts of the support part (4) are oriented in parallel to the pillar grid of the vertical frame of the building and/or obliquely to the grid.

10. A horizontal structural system according to Claim 9, characterized in that each support part has an even number of cantilever beams (7), tension bars (15, 23) or tension bar groups, and they extend in pairs in opposite directions in relation to each other from the vertical member (6) in question.

11. A horizontal structural system according to any of the above claims, characterized in that the basic component (25) at least in part bearing on the support part (4) has the shape of a polygon, in at least one corner of which or on at least one side of which there is provided a fixed support part or support-part fastening means (30) and that these support-part branches (7, 15, 23) or their fastening means (30) are arranged symmetrically in relation to the bisector (P) of this corner of the component.

12. A horizontal structural system according to Claim 11, characterized in that the branches (15.1-15.8) of the support parts of the basic components (25a, b, c or d), or their fastening means, are located in such a manner in relation to the said corner of the basic component that, when the corresponding corner of another corresponding basic component (25b, c, d or a) is placed next to it, they form, when the support parts (15.1-15.5; 15.2-15.6; 15.3-15.8; 15.4-15.7, etc.) of the different components coming approximately opposite to each other are connected to each other, a combination which draws the components (25a...d) bearing on said vertical member (6) towards each other horizontally.

13. A horizontal structural system according to any of the above claims, characterized in that the tension bars (15, 23) are tightened after in situ casting or after the installation of the components, in order to produce pre-tensioning in the load-bearing horizontal slab (1) or the basic component (25) and/or to set the position of the horizontal slab or the corresponding component.

14. A horizontal structural system according to any of Claims 11-13, characterized in that the basic component (25) supported by the load-bearing vertical structures is a hexagonal component or a variant of the said hexagonal component, which has been implemented by enlarging or reducing the slab-like
portion of the hexagonal component and/or by shaping it in one or several corners or other parts of the component, and which variant of the component may include a varying number of load-bearing parts at different points of the component.

15. A horizontal structural system according to any of Claims 6-14, characterized in that the basic and/or additional component (25, 26) consists of a flat slab which possibly contains reinforcement bars or frogs of or a twin-slab structure which is provided with fastening parts, structures and/or recesses (35) for the purpose of suspension and/or fastening (40, 41) in order to support the component in relation to another component and/or to stiffen the structure.

16. A horizontal structural system according to any of Claims 6-15, characterized in that the basic component (25) is fixedly provided with steel cables, tension bars, trentles, rib beams or other corresponding support parts (4) above the slab part or, in a twi

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durch gekennzeichnet, daß die lasttragenden, im wesentlichen waagerechten Platten (1) wesentlich dünner sind als die nach der Herstellung sichtbare Bauhöhe der Zwischendecken, des Daches und des Erdgeschosses des Gebäudes, daß das Tragteil (4), welches sich in waagerechter Richtung oder unter einem geringen Neigungswinkel zu der Platte (1) von irgendeinem senkrechten Teil des senkrechten Tragrahmens aus erstreckt, sich über der Platte befindet und an ihr wenigstens in einem Punkt befestigt ist, der sich in einem waagerechten Abstand vom in Frage stehenden senkrechten Teil befindet, um die Platte (1) von außerhalb des senkrechten Teiles (6) zu tragen, und daß das Tragteil wenigstens im wesentlichen in den sichtbaren waagerechten Strukturen des Gebäudes enthalten ist.

2. Waagerechtes Struktursystem gemäß Anspruch 1, dadurch gekennzeichnet, daß die waagerechte Platte (1), die den Tragrahmen einer Zwischendecke eines Daches oder eines Erdgeschosses bildet, Basiskomponenten (25) beinhaltet, die unmittelbar von dem besagten Tragteil (4) getragen werden und, falls notwendig, zusätzliche Komponenten (26), die zwischen diesen Basiskomponenten angeordnet sind und von diesen getragen werden.

3. Waagerechtes Struktursystem gemäß Anspruch 1 oder 2, dadurch gekennzeichnet, daß das Tragteil (4) aus einem oder mehreren Krag Balken oder -böcken (7) besteht, der/die sich in Winkelabständen von der senkrechten Stütze (6) oder senkrechten Wand oder einer anderen senkrechte Lasten übertragenden Struktur weg in eine Ebene erstreckt, die sich hierzu näherungsweise rechtwinklig befindet, wobei dessen/deren Unterseite (11) oder ein Teil von dieser an der waagerechten Platte (1) befestigt ist, um diese Platte zu tragen.

4. Waagerechtes Struktursystem gemäß Anspruch 1 oder 2, dadurch gekennzeichnet, daß das Tragteil (4) aus einem oder mehreren einzelnen Zugstäben oder dergleichen (15) besteht, die sich einzeln oder in Gruppen in horizontalen Winkelabständen von der senkrechten Stütze (6) oder einer senkrechten Wand oder einer anderen senkrechte Lasten übertragenden Struktur schräg nach unten zu der waagerechten Platte (1) erstreckt, und die, um die Platte zu tragen, sowohl an dem in Frage kommenden senkrechten Stützteil als auch an der in Frage kommenden waagerechten Platte befestigt sind.

5. Waagerechtes Struktursystem gemäß Anspruch 3 oder 4, dadurch gekennzeichnet, daß das Tragteil (4) als Kombination von Zugstäben (9, 15, 23) und Krag balken oder -böcken (7) ausgebildet ist, wobei die Zugstäbe innerhalb der Krag balken (7) näherungsweise in Lastrichtung verlaufen, von der Balkenoberseite (11) nahe bei seinem Außenende (8) oder alternativ in der Verlängerung der Krag balken von deren Oberseite (10) hinunter zu der waagerechten Platte (1).
6. Waagerechtes Strukturystem gemäß einem or mehreren der vorangegangenen Ansprüche, dadurch **gekennzeichnet**, daß die waagerechte Platte (1) oder die Basiskomponente (25) den strukturellen Anteil des Tragteils (4) bildet und daß das Tragteil entweder mit der horizontalen Platte durch einen Gießvorgang an Ort und Stelle oder mit der Basiskomponente durch den Gießvorgang dieser vor- gefertigten Komponente verbunden ist.

7. Waagerechtes Strukturystem gemäß einem oder mehreren der vorangegangenen Ansprüche, dadurch **gekennzeichnet**, daß die waagerechte Platte (1) oder die Basiskomponente (25) oder das Tragteil (4) gleichzeitig eine waagerechte Verlängerung der Stützkomponente (6) oder der zugehörigen Wand bilden.

8. Waagerechtes Strukturystem gemäß einem oder mehreren der vorangegangenen Ansprüche, dadurch **gekennzeichnet**, daß die besagten Krag balken (7) und/oder die Zugstangen (15, 23) oder andere zugehörige Tragteile (4) in ihrer Gesamtheit zwischen der waagerechten Platte (1) und der auf der Oberseite der Platte (1) errichteten Deckenzwischenraumbedeckung (2) angeordnet sind, und daß der Zwischenraum (3) zwischen der waagerechten Platte und der Deckenzwischenraumbedeckung zum Gebrauch als Zwischenraum für Installationen verfügbar ist.


11. Waagerechtes Strukturystem gemäß einem oder mehreren der oben genannten Ansprüche, dadurch **gekennzeichnet**, daß die Basiskomponente (25), die wenigstens zum Teil von dem Tragteil (4) getragen ist, die Gestalt eines Polygons hat, in wobei in wenigstens einer Ecke oder auf wenigstens einer Seite des Polygons ein festes Tragteil oder Tragteil-Befe stigungsmittel (30) vorgesehen sind und diese Tragteilabschnitte (7, 15, 23) oder deren Befestigungsmittel (30) in Bezug auf die Halbierende (P) dieser Ecke der Komponente symmetrisch angeordnet sind.

12. Waagerechtes Strukturystem gemäß Anspruch 11, dadurch **gekennzeichnet**, daß die Abschnitte (15.1 - 15.8) der Tragteile der Basiskomponenten (25a, b, c oder d) oder deren Be festigungsmittel in Bezug auf die besagte Ecke der Basiskomponente so angeordnet sind, daß in dem Fall, wenn die passende Ecke einer anderen zugehö rigen Basiskomponente (25b, c, d oder a) neben diese erste Basiskomponente gesetzt wird und wenn die Tragteile (15.1-15.5; 15.2-15.6; 15.3-15.8; 15.4-15.7 etc.) der verschiedenen Komponenten in eine nahe rungsweise sich gegenüberliegende Position kommen und in dieser Position miteinander verbunden werden, diese Komponenten eine Kombination bilden, die die von dieser Stütze (6) oder einer senkrechten Wand getragenen Komponenten (25a-d) waagerecht gegeneinanderzieht.

13. Waagerechtes Strukturystem nach einem oder mehreren der vorangegangenen Ansprüche, dadurch **gekennzeichnet**, daß die Zugstäbe (15,23) nach dem Gießen an Ort und Stelle oder nach der In stallation der Teile gespannt werden, sodaß sie in der waagerechten Platte (1) oder der Basiskomponente (25) eine Vorspannung hervorrufen und/oder daß sie die Lage der waagerechten Platte oder der zugehörigen Komponente festsetzen.


15. Waagerechtes Strukturystem nach einem oder mehreren der vorangegangenen Ansprüche 6-14, dadurch **gekennzeichnet**, daß die Basiskomponente und/oder Zusatzkomponenten (25, 26) aus einer flachen Platte, die wahlweise Verstärkungsstäbe oder Versteifungslagel enthält, oder aus einer zweilagigen Plattenstruktur besteht, die mit Befestigungs- elementen, Strukturen und/oder Aufnahmen (35) versehen ist, die den Zweck haben, durch Aufhängung und/oder Befestigung (40, 41) eine Komponente in Verbindung zu einer anderen Komponente zu halten und/oder die Struktur zu versteifen.


17. Waagerechtes Strukturystem gemäß einem oder mehreren der Ansprüche 6 - 16, dadurch ge-
kennzeichnet, daß die Basiskomponenten (25) und/oder die Zusatzkomponenten (26) mit einer Schwalbenschwanznut (35) oder einer mit Stahlkanten versehenen Aufnahme (32,33) ausgestattet sind, in die Verbindungselemente (34, 37, 39) eingebracht werden, die an beiden Enden verdickt oder in anderer Weise so geformt sind, daß eine ausreichende Haftung gewährleistet ist, und die die Komponenten verbinden und die Fuge (36) versteifen und, falls notwendig, zusammen mit dem Einbringen einer Vergußmasse (38,45) die Komponenten verbinden und ausreichend versteifen.

18. Waagerechtes Struktursystem nach einem oder mehreren der Ansprüche 6 - 17, dadurch gekennzeichnet, daß die plattenförmigen lasttragenden Basiskomponenten (25) getragen werden und/oder miteinander verbunden werden durch Schweißung, Schraubung, Vergießen, Vorspannen und/oder durch andere Befestigungsmethoden in der Absicht, die waagerechte Struktur (1) zu versteifen.


Reversedictions

1. Système structural horizontal support de charge pour un édifice, comportant des dalles (1) supports de charge et des structures analogues à une dalle qui constituent le cadre de ladite structure horizontale et des parties supports (4) qui transfèrent des charges depuis ces dalles aux éléments (6) verticaux supports de charge du cadre de l'édifice (5) et s'étendent dans le sens horizontal jusqu'à la section transversale d'un élément vertical et quelconque (6) à la surface de la dalle, caractérisé en ce que les dalles (1) principalement horizontales supports de charge sont sensiblement plus minces que l'épaisseur structurale visible finale du plancher intermédiaire du toit et du plancher de base de l'édifice, en ce que la partie supérieure (4) s'étendant depuis un élément vertical donné quelconque (6) du cadre de l'édifice (5) dans le sens horizontal ou faisant un angle faible avec la dalle (1) se trouve au-dessus de la dalle et est fixée à celle-ci au moins en un point qui se trouve à une distance horizontale de l'élément vertical en question, pour soutenir la dalle (1) depuis l'extérieur de l'élément vertical (6), et en ce que la partie support (4) au moins pour l'essentiel est continue dans les structures horizontales visibles de l'édifice.

2. Système structural horizontal selon la revendication 1, caractérisé en ce que la dalle horizontale (1) constituant le cadre d'un plancher intermédiaire, d'un toit ou d'un plancher de base est constituée de constitutants fondamentaux (25) s'appuyant directement sur ladite partie support (4) et, lorsque cela est nécessaire, de constitutants supplémentaires (26) disposés entre ces constitutants fondamentaux et s'appuyant sur eux.

3. Système structural horizontal selon la revendication 1 ou 2, caractérisé en ce que la partie support (4) est constituée d'une ou de plusieurs poutres en porte-à-faux ou de chevalets en porte-à-faux (7) qui s'étendent en s'écartant angulairement dudit élément vertical (6), dans un plan approximativement perpendiculaire à celle-ci, et sont fixés par leur surface inférieure (11) ou une partie de celle-ci à la dalle horizontale (1) pour supporter la dalle.

4. Système structural horizontal selon la revendication 1 ou 2, caractérisé en ce que la partie support (4) est constituée d'une ou de plusieurs barres de tension distinctes ou analogues (15) qui s'étendent séparément ou en groupes dans l'écart horizontal dudit élément vertical (6) obliquement vers le bas vers la dalle horizontale (1), et qui sont fixées à la fois à la partie de cadre vertical et à la dalle horizontale et en question et à la dalle horizontale en question pour supporter la dalle.

5. Système structural horizontal selon la revendication 3 ou 4, caractérisé en ce que la partie support (4) est constituée d'une combinaison de barres de tension (9, 15, 23) et de poutres en porte-à-faux ou de chevalets en porte-à-faux (7) aux barres de tension s'étendant dans les poutres en porte-à-faux approximativement dans le sens de la charge à partir de la surface supérieure de la poutre (10) proche d'un élément vertical vers la surface inférieure de la poutre (11) près de son extrémité extérieure (8), ou en variante sur le prolongement des poutres en porte-à-faux depuis leur surface supérieure (10) vers le bas en direction de la dalle horizontale (1).

6. Système structural horizontal selon l'une quelconque des revendications précédentes, caractérisé en ce que la dalle horizontale (1) ou le constituant fondamental (25) constitue la partie structurale de la partie support (4) et en ce que la partie support est reliée, soit à la dalle horizontale par rapport à un coulage en situ, soit au constituant fondamental par rapport au coulage de l'élément préfabriqué.

7. Système structural horizontal selon l'une quelconque des revendications précédentes, caractérisé en ce que la dalle horizontale (1) ou le constituant fondamental (25) ou la partie support (4) constitue simultanément un prolongement vertical de l'élément (6) ou de la paroi correspondante.

8. Système structural horizontal selon l'une quelconque des revendications précédentes, caractérisé en ce que lesdites poutres en porte-à-faux (7) et/ou les barres de tension (15, 23) ou autres parties supports correspondantes (4) se trouvent en totalité
entre la dalle horizontale (1) et le plancher encastré (2) édifié sur le sommet de la dalle, et en ce que l'espace (3) entre la dalle horizontale et le plancher encastré est disponible pour une utilisation en tant qu'espace encastré pour des installations.

9. Système structural horizontal selon l'une quelconque des revendications précédentes, caractérisé en ce que les poutres en porte-à-faux (7), les barres de tension (15, 23) ou les groupes de barres de tension ou des parties supports de charge correspondantes de la partie support (4) sont orientées parallèlement à la grille du cadre vertical de l'édifice et/ou obliquement par rapport à la grille.

10. Système structural horizontal selon la revendication 9, caractérisé en ce que chaque partie support possède un nombre pair de poutres en porte-à-faux (7), de barres de tension (15, 23) ou des groupes de barres de tension, et s'étendent par paires dans des sens opposés entre elles à partir de l'élément vertical (8) en question.

11. Système structural horizontal selon l'une quelconque des revendications précédentes, caractérisé en ce que le constituant fondamental (25), au moins dans une partie reposant sur la partie support (4), présente la forme d'un polygone, dans au moins un sommet duquel ou sur au moins un côté duquel est prévue une partie support fixe ou des moyens de fixation d'une partie support (30) et en ce que ces ramifications de partie support (7, 15, 23) ou leurs moyens de fixation (30) sont disposés symétriquement par rapport à la bissectrice (P) de ce sommet du constituant.

12. Système structural horizontal selon la revendication 11, caractérisé en ce que les ramifications (15, 1-15, 8) des parties supports des constitutants fondamentaux (25a, b, c ou d), ou leurs moyens de fixation, sont situées de telle manière, par rapport audit sommet du constituant fondamental, que lorsque le sommet correspondant d'un autre constituant fondamental correspondant (25b, c, d ou a) est placé près de lui, ils forment, lorsque les parties supports (15, 1-15, 5 ; 15, 2-15, 8 ; 15, 3-15, 8 ; 15, 4-15, 7, etc.) des différents constitutants venant approximativement en face les unes des autres sont reliées l'une à l'autre, un combinaison qui attire les constitutants (25a ... d) reposant sur ledit élément vertical (8) l'un vers l'autre horizontalement.

13. Système structural horizontal selon l'une quelconque des revendications précédentes, caractérisé en ce que les barres de tension (15, 23) sont tendues après coulage en situ ou après installation des constitutants, afin de créer une précontrainte dans la dalle horizontale support de charge (1) ou le constituant fondamental (25) et/ou pour régler la position de la dalle horizontale ou du constituant correspondant.

14. Système structural horizontal selon l'une quelconque des revendications 11 à 13, caractérisé en ce que le constituant fondamental (25) supporté par les structures verticales supports de charge est un constituant hexagonal ou une variante dudit constituant hexagonal, qui a été réalisé en élargissant ou en réduisant la partie analogue à une dalle du constituant hexagonal et/ou en la façonant en un ou plusieurs sommets ou autres parties du constituant, et laquelle variante du constituant peut comprendre un nombre variable de parties supports de charge en différents points du constituant.

15. Système structural horizontal selon l'une quelconque des revendications 6 à 14, caractérisé en ce que le constituant fondamental et/ou supplémentaire (25, 26) consiste en une dalle plane qui contient éventuellement des barres de renfort ou des croisillons ou en une structure de dalle double munie d'éléments de fixation, de structures et/ou d'évidements (35) pour une suspension et/ou une fixation (40, 41) afin de supporter le constituant par rapport à un autre constituant et/ou rigidifier la structure.

16. Système structural horizontal selon l'une quelconque des revendications 6 à 15, caractérisé en ce que le constituant fondamental (25) est muni à demeure de câbles d'acier, de barres de tension, de chevalets de membranes ou d'autres parties supports correspondantes (4) au-dessus de la dalle ou, dans le cas d'une dalle double, au-dessus de la dalle inférieure, afin de supporter le constituant.

17. Système structural horizontal selon l'une quelconque des revendications 6 à 16, caractérisé en ce que les constitutants fondamentaux (25) et/ou les constitutants supplémentaires (26) sont munis d'une encoche en queue d'aronde (35) ou d'un évidement à bord en acier (32, 33), dans lequel sont disposés des éléments de liaison (34, 37, 39), épaisseur ou deux extrémités ou façonnés différemment de manière à obtenir une liaison suffisante, qui reliant entre les constitutants et renforcent le joint (36) et, lorsque cela est nécessaire, conjointement avec un jointoyage (38, 45), relient entre eux et rigidifient suffisamment les constitutants.

18. Système structural horizontal selon l'une quelconque des revendications 6 à 17, caractérisé en ce que les constitutants fondamentaux supports de charge en forme de dalle (25) sont supportés et/ou reliés entre eux par soudage, boulonnage, coulage, précontrainte, et/ou par d'autres procédés de fixation afin de rigidifier la structure horizontale (1).

19. Système structural horizontal selon l'une quelconque des revendications précédentes, caractérisé en ce que la structure support du plancher encastré (2) s'appuie sur la zone du point de liaison (19) entre l'extrémité (8) de la poutre en porte-à-faux ou du chevalet en porte-à-faux (7) de la partie support (4), ou sur la barre de tension (15) et la dalle (1), ou entre de tels points.
Fig. 12
Fig. 23
Fig. 24