

Element plate for producing a semi-precast floor slab

The invention relates to an element plate for producing a semi-precast floor slab, comprising a reinforced concrete panel which has an element panel length along a longitudinal extension direction and an element panel width along a transverse direction perpendicular to the longitudinal extension direction, and from whose upper side several displacement devices protrude, each of which has at least one hollow vessel, the vessel opening of which is arranged in the concrete panel and is closed by the concrete of the concrete panel, wherein the element plate has a plurality of longitudinal reinforcing bars extending in the longitudinal extension direction, which are arranged at a distance from the upper side of the concrete panel.

The invention also relates to a semi-precast floor slab comprising a plurality of element plates and a concrete component, in particular a concrete slab, comprising a plurality of element plates.

Furthermore, the invention relates to a method for manufacturing an element plate and a method for manufacturing a concrete component.

Semi-precast floor slabs are frequently used due to their advantages. They are assembled on the construction site from prefabricated element plates and serve as part of a formwork that is filled with an additional layer of concrete as cast-in-place concrete in order to produce the desired concrete slab.

In the classic production of concrete slabs using the pure cast-in-place concrete method, i.e., without the use of element plates for semi-precast floor slabs, displacement bodies are often arranged in the space surrounded by formwork where this is structurally possible. This has the advantage that the spaces occupied by the displacement bodies remain free of concrete, so that concrete is saved and lighter concrete slabs can be produced.

For example, European patent application EP 1 568 827 A1 proposes enclosing displacement bodies, which are for example designed as plastic balls, in lattice structures that are open on one side, and then pressing these modules into a first or second layer of concrete, which may already contain a first reinforcement mat. The semi-finished product produced in this way is then covered with concrete during subsequent completion.

European patent application EP 0 617 180 A2 proposes arranging box elements made of extruded foam sheets of polypropylene and/or other suitable waterproof plastics in the space

between metal grids protruding from a reinforced concrete floor slab, which are then covered with concrete over the entire length of this space, with or without interruptions. The box elements are open at the bottom and equipped with transverse closure walls and stiffening walls that are fastened by wedging and/or other suitable means.

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Attempts to use displacement bodies in semi-precast floor slabs are also known. For example, DE 603 09 733 T2 discloses a building element and a method for its manufacture. The building element has a "hardened concrete layer," which can also be referred to as a concrete panel, as well as reinforcing elements, whereby the reinforcing elements extend partially upward from the hardened concrete layer. The building element also has elements that define cavities, which can have the shape of an inverted flower pot in particular.

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With regard to the stability of a concrete slab manufactured using element plates, the transition areas from one element plate to the next are particularly critical.

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It is therefore the object of the present invention to provide an element plate that makes it possible to save concrete and to produce particularly stable concrete slabs, especially flat slabs.

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The object is achieved by an element plate characterized in that a groove running in the transverse direction is formed between adjacent hollow vessels, into which a reinforcing bar can be inserted in the transverse direction in such a way that it protrudes laterally beyond the concrete panel.

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In a particularly advantageous embodiment, the grooves are designed and arranged in such a way that several reinforcing bars can be inserted at equal intervals so that a reinforcing bar is arranged in each groove running in the transverse direction and adjacent reinforcing bars have a distance of 40 cm or less, in particular at a distance in the range of 15 to 30 cm or in the range of 20 cm to 25 cm or 20 cm. This makes it possible to arrange the reinforcing bars across the element plates in a number and density that is advantageous for the stability of the concrete component to be manufactured when producing a concrete component, in particular a concrete slab, using several of the element plates according to the invention, which are arranged along their long sides, in particular immediately next to each other.

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Preferably, the grooves each have a width in the range of 3 cm to 10 cm, in particular in the range of 3 cm to 7 cm or in the range of 6 cm to 8 cm or 5 cm. The special spacing advantageously ensures that, after filling with cast-in-place concrete, the reinforcing bars are completely surrounded in every direction by a thickness of concrete that is advantageous for

the stability of the concrete component.

According to the invention, the element plate has several longitudinal reinforcement bars running in the longitudinal extension direction. The longitudinal reinforcement bars are preferably
 5 spaced apart from the upper side of the concrete panel and/or arranged parallel to the upper side of the concrete panel. In this way, a particularly high stability and rigidity of the concrete component to be manufactured is achieved.

In a particularly advantageous embodiment, reinforcement elements, in particular in the form of
 10 lattice girders, to which the longitudinal reinforcement bars are attached, protrude from the concrete panel. The longitudinal reinforcing bars can be attached in particular to the free ends of the reinforcing elements. Such an embodiment makes it possible in a particularly advantageous manner to arrange the longitudinal reinforcing bars at a distance from the top of the concrete panel and/or parallel to the top of the concrete panel.

15 A particularly advantageous embodiment is one in which the reinforcement elements are arranged in several straight and mutually parallel rows and one of the longitudinal reinforcement bars is attached to each of the reinforcement elements in a row. The statics of such an embodiment are comparatively easy to calculate and must be taken into account in
 20 the manufacture of a semi-finished slab. In addition, such an embodiment can be manufactured particularly efficiently, especially with the aid of robots. In such an embodiment, it may be advantageous in particular to provide that at least one row of reinforcement elements runs between each two straight and mutually parallel rows of displacement devices.

25 Preferably, the reinforcement elements and/or the longitudinal reinforcement bars are designed and arranged in such a way that they do not hinder or even prevent the reinforcement bars from being inserted into the grooves 14 across the element plates. For this purpose, it may be advantageous to provide that the alignments of the grooves 14 remain free of reinforcement elements and longitudinal reinforcement bars.

30 A particularly stable and rigid embodiment of the element plate is one in which the longitudinal reinforcement bars extend over the entire length of the element plate or have at least one longitudinal reinforcement bar length that is 0.8 to 1.0 times, in particular 0.9 to 1.0 times, the length of the element plate.

35 The element plate width can, for example, be in the range from 0.6 m to 2.4 m. The element plate length can advantageously be up to 12 m or more.

In an advantageous embodiment, at least one support element with a support section arranged outside the concrete panel for supporting a reinforcing bar is arranged on the outside of at least one of two adjacent hollow vessels, wherein the support section preferably has a distance from the upper side of the concrete panel in the range of 0.5 cm to 3 cm, in particular in the range of 0.5 cm to 1.5 cm. This has the particular advantage that a particularly good stability of the concrete component to be manufactured can be achieved by the fact that reinforcing steel, in particular in the form of reinforcing bars, can be easily installed on the construction site. In particular, the reinforcing bars, especially across element plates, can be easily placed on the support sections of the support elements of the displacement devices. The special distance between the support sections and the top of the concrete panel, in the range of 0.5 cm to 3 cm, ensures, on the one hand, that the reinforcement can be installed at a short distance from the top of the concrete panel in a statically advantageous manner and, on the other hand, that the reinforcement (apart from the points where it rests on the support sections) is completely encased in concrete when filled with cast-in-place concrete.

As already mentioned, this has the particular advantage that the reinforcement, especially in the form of reinforcing bars, can be laid across element plates. In particular, reinforcing bars can be advantageously installed in such a way that they rest both on the support sections of the displacement devices of an element plate according to the invention and on the support sections of the displacement devices of an immediately adjacent element plate according to the invention (in particular, the same element plate). In this case, the displacement devices can be designed and arranged in a particularly advantageous manner so that the reinforcing bars can be installed at a distance of 40 cm or less, in particular at a distance in the range of 15 to 30 cm or 20 cm to 25 cm, or in particular at a distance of 20 cm. This advantageously ensures that a semi-precast floor slab produced in this way and reinforced by means of reinforcement bars spanning the element plates is particularly stable, especially in the transition areas from one element plate to the next. As a result, the concrete slab ultimately produced is also particularly stable. In particular, the invention makes it possible to produce particularly flat concrete slabs in element plate construction that are nevertheless particularly stable.

The support element can advantageously be elongated and/or designed as a support bar, in particular a cylindrical support bar. This has the advantage that the contact area with the applied reinforcement bar is particularly small, so that only this small surface area of the applied reinforcement bar remains free of cast-in-place concrete during the concreting process on the construction site.

In a particularly advantageous embodiment, the support section has a concave shape and/or is designed to be concavely curved. This has the particular advantage that a target position for

the reinforcing bar is defined because the reinforcing bar tends to roll and/or slide to the lowest point of the support section. This avoids the need for an employee to manually align and fix the reinforcing bar in detail. This also prevents the reinforcing bar from unintentionally resting on other parts of the element plate, such as the wall of the hollow vessel, except at the support sections.

In a particularly cost-effective yet very robust embodiment, at least one support element and the hollow vessel are manufactured together in one piece, in particular by injection molding. In particular, the at least one support element and the hollow vessel can be advantageously manufactured, in particular together in one piece, by plastic injection molding.

Although it is not fundamentally excluded, the hollow vessel is preferably not cuboid in shape. A cuboid shape of the hollow vessel would result in beams running essentially between the hollow vessels being concreted, which would reduce the stability of the concrete slab.

Particularly stable concrete slabs can be achieved with element plates in which at least one section of the wall of the hollow vessel, in particular each of the hollow vessels, is curved. In particular, it may be advantageous to provide that at least one section of the wall of the hollow vessel has a curved, in particular circular, section in a cross-sectional plane parallel to the upper side of the concrete panel. In a particularly advantageous design, a section of the wall of the hollow vessel has the shape of a spherical segment.

Preferably, several of the displacement bodies and/or several of the hollow vessels of the element plate are of identical design. In particular, all displacement bodies and/or all hollow vessels of the element plate may be of identical design.

In a special embodiment, the element plate has at least two displacement devices which differ from each other in terms of their shape and/or their size and/or their volume. For example, smaller displacement devices with a lower displacement volume may be arranged in an area of the element plate in which a greater load is to be expected in the concrete component to be manufactured, while larger displacement devices with a larger displacement volume are arranged in an area of the same element plate where a lower load is to be expected in the concrete component to be produced. This has the advantage that the concrete component has more concrete in the area of higher load than in the area of lower load.

The element plate may (alternatively or additionally) also have at least one area with displacement devices, while another area is free of displacement devices, even though it is large enough to accommodate displacement devices of the same size. This has the advantage

that the concrete component in the free area has the maximum possible amount of concrete and therefore has particularly high stability and/or load-bearing capacity there.

5 The wall of at least one of the hollow vessels, in particular of all hollow vessels of the element plate, may have at least one flat section. For example, the flat section may be arranged at an angle of 70 degrees to 90 degrees to the upper side of the concrete panel. In particular, this section may delimit a groove between two hollow vessels of a displacement device, which is described in detail below.

10 Alternatively or additionally, the wall of at least one of the hollow vessels, in particular of all hollow vessels of the element plate, may have a section that is parallel to the upper side of the concrete panel, in particular a flat section. This may advantageously be the upward-facing bottom of the hollow vessel with the vessel opening facing downwards.

15 At least one spacer may advantageously be arranged on the upper side of at least one of the hollow vessels, in particular all hollow vessels of the element plate. The spacer may, for example, be designed in the form of a web and/or a rib. In particular, the spacer may be manufactured integrally with the wall of the hollow vessel. Further reinforcements, in particular reinforcing bars or reinforcing mats, can be placed on the spacer at the construction site prior to a concreting process, whereby the spacers prevent direct contact between the further reinforcement and the wall of the hollow vessel. This has the advantage that the contact area with the additional reinforcement is particularly small in each case, so that only a small surface area of the additional reinforcement remains free of cast-in-place concrete during the concreting process on the construction site.

25 Preferably, the support element is shorter in one direction, in particular vertically, away from the wall of the hollow vessel than the length and width of the vessel opening. Such a design is sufficient for the installation of the reinforcing bars and allows particularly efficient positioning of the displacement devices relative to each other without mutual obstruction. The length can advantageously be in the range of 2 cm to 7 cm.

30 An embodiment in which the support element protrudes, in particular vertically, from the wall of the hollow vessel is particularly advantageous. This means that the support element only takes up the space required for its function.

35 Preferably, several support elements are arranged on the outside of the hollow vessel. In particular, several support elements can be arranged on the outside of the hollow vessel, protruding in different directions, in particular in opposite directions from the wall of the hollow

vessel. Such a design allows reinforcing bars, in particular parallel to each other, to be placed on opposite sides of the hollow vessel.

5 In a particularly advantageous embodiment, the wall of at least one of the hollow vessels, in particular each hollow vessel, has a vessel opening edge which is arranged in the concrete panel. This anchors the hollow vessel securely and inseparably in the concrete panel. The vessel opening edge can advantageously have a height in the range of 0.5 cm to 3 cm in the vertical direction. In particular, the vessel opening edge can be bounded at the top by a collar arranged on the outside of the displacement device and/or the hollow body. In a particularly
10 advantageous manner, the collar can rest on the upper side of the concrete panel. The collar can advantageously have a width in the range of 0.5 cm to 2 cm.

In particular, it can be advantageously provided that the vessel opening edge stands up in the concrete panel in direct contact with a reinforcement. Such a design can be produced, for
15 example, by first arranging at least one reinforcement in a formwork and then placing the at least one displacement device, in particular a plurality of displacement devices, on the reinforcement, each with the vessel opening directed towards the reinforcement, in such a way that the vessel opening edge is in direct contact with the reinforcement. The concrete panel is then concreted by pouring in liquid concrete, whereby so much liquid concrete is poured into
20 the formwork until the vessel opening edge is surrounded by concrete. In particular, as already mentioned, it may be advantageous to provide that the hollow vessel and/or the displacement device has a circumferential collar which marks an upper end of the vessel opening edge and up to which the liquid concrete is poured into the formwork to produce the concrete panel.

25 In a particularly advantageous embodiment, at least one of the displacement devices, in particular each of the displacement devices, has one, in particular exactly one, further hollow vessel, wherein the hollow vessel and the further hollow vessel are connected to each other by means of the at least one support element. Such an embodiment has the particular advantage that reinforcing bars can be arranged both laterally next to the hollow vessels and between the
30 hollow vessels on the support elements. Such an embodiment also has the further particular advantage that it is particularly easy to handle during the production of the element plate. Such an embodiment is particularly stable when the hollow vessel and the further hollow vessel are connected to each other by means of several support elements. Preferably, at least two of the connecting support elements are of identical design and/or arranged parallel to each other.

35 Preferably, the support section of each of the support elements is spaced from the upper side of the concrete panel in the range from 0 cm to 3 cm. This has the advantage that the reinforcing bars, in particular parallel to the upper side of the concrete panel, can be placed at a small

distance from the upper side of the concrete panel in such a way that they are completely encased in concrete (apart from the points where they rest on the support sections) when filled with cast-in-place concrete.

- 5 In a particularly cost-effective yet very robust embodiment, the at least one support element and the hollow vessel and the further hollow vessel are produced together in one piece, in particular by injection molding. In particular, the at least one support element and the hollow vessel and the further hollow vessel can be advantageously produced by plastic injection molding.

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As already mentioned, the displacement device can be advantageously designed such that a groove is formed between the hollow vessel and the further hollow vessel. The groove can advantageously have a width in the range of 3 cm to 10 cm, in particular in the range of 3 cm to 7 cm or in the range of 6 to 8 cm or 5 cm. This makes it possible to insert a reinforcing bar easily and without complication. In addition, with such a width of the groove, it is ensured that the reinforcing bar (apart from the points where it rests on the support sections) is completely encased in concrete when filled with cast-in-place concrete.

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As already mentioned, the groove can be formed partly by a particularly flat outer wall of the hollow vessel and partly by a particularly flat outer wall of the further hollow vessel of the displacement device.

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In a special embodiment, the outer walls of the hollow vessel and the further hollow vessel, which form part of the groove, are arranged in planes that form an angle of between 0 degrees and 30 degrees to each other. Such an embodiment has the particular advantage that the in-situ concrete can flow reliably into the groove and surround the inserted reinforcing bar or bars.

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Preferably, the hollow vessel and the further hollow vessel are of identical design. At least, it may be advantageous to provide that the hollow vessel and the further hollow vessel are of identical size and/or that the hollow vessel and the further hollow vessel have the same shape.

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In a particularly advantageous embodiment, the hollow vessel and the further hollow vessel are designed and arranged to be mirror-symmetrical to each other. Such an embodiment has the particular advantage that the displacement device and the concrete structure of the concrete slab formed around it have symmetrical stability properties.

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Preferably, the vessel opening of the further hollow vessel is also arranged in the concrete panel and closed by the concrete of the concrete panel. Alternatively or additionally, it may be

advantageous to provide that the vessel openings of the hollow vessel and the further hollow vessel are arranged completely in a common plane.

5 In a particularly advantageous embodiment, the space above the at least one support element is free. This makes it particularly easy to place a reinforcing bar.

10 In an advantageous embodiment of the element plate according to the invention, several displacement devices are arranged in at least one, in particular straight, row. In particular, the distance between immediately adjacent displacement devices in the row can advantageously be in the range of 3 cm to 10 cm, in particular in the range of 3 cm to 7 cm or in the range of 6 cm to 8 cm, or in particular 5 cm.

15 It can be particularly advantageous for the element plate to have several rows of displacement devices, in particular parallel to each other. In particular, it can be advantageous to arrange several displacement devices, in particular identical ones, in several parallel, in particular straight, rows. In such an embodiment, it may also be advantageous to provide that at least one of the reinforcement elements of the element plate, in particular a reinforcement element designed as a lattice girder, protrudes from the upper side of the concrete panel between the rows parallel to each other.

20 A semi-precast floor slab comprising several element plates according to the invention is particularly advantageous. Preferably, the element plates are designed identically.

25 The element plates of the semi-precast floor slab can be arranged relative to each other in such a way that reinforcement bars can be inserted or are inserted across the element plates parallel to each other at a distance of 40 cm or less, in particular at a distance in the range of 15 to 30 cm or 20 cm to 25 cm or at a distance of 20 cm can be inserted or are inserted into the grooves of adjacent element plates. Preferably, each groove contains exactly one reinforcing bar, although it is not excluded that several reinforcing bars may be arranged in at least one groove, 30 in particular in all grooves.

35 In particular, it may be advantageous to arrange the element plates of the semi-precast floor slab in such a way and to design and arrange their displacement devices in such a way that the reinforcing bars are arranged parallel to each other across the element plates at a distance of 40 cm or less, in particular at a distance in the range of 15 to 30 cm or 20 cm to 25 cm or at a distance of 20 cm, on support sections of the displacement devices of adjacent element plates. In this way, it is advantageous to ensure that each of the reinforcement bars extending across the element plates rests on support sections belonging to different element plates.

The element plate according to the invention can be advantageously manufactured in such a way that at least one reinforcement is arranged in a formwork, on which (preferably in straight rows parallel to each other) the displacement devices are placed. In this case, a programmable automatic movement device, in particular an industrial robot, can be advantageously used to place the displacement devices. In this way, a high degree of accuracy is achieved, which is important in order to be able to place the required reinforcement bars in the required manner later on, after the finished element plate has been installed on the construction site. The formwork is then filled with liquid concrete until the vessel opening edges are positioned in the concrete and the vessel openings are sealed by the concrete, whereby it may be advantageous to fill the formwork with liquid concrete to such a height that the support sections of the support elements are spaced from the top of the concrete panel in the range of 0.5 cm to 3 cm, in particular in the range of 0.5 cm to 1.5 cm. The displacement devices are preferably placed on the reinforcement in such a way that the groove running in the transverse direction is formed between adjacent hollow vessels, into which a reinforcing bar can be inserted in the transverse direction in such a way that it protrudes laterally beyond the concrete panel.

According to a particularly advantageous method, the element plate according to the invention is manufactured in such a way that at least one reinforcement is arranged in a formwork and the formwork is then filled with liquid concrete. The displacement devices (preferably several displacement devices in rows) are then pressed into the concrete, which has not yet hardened, until the vessel opening is located in the concrete and sealed by the concrete. The displacement devices are preferably pressed into the uncured concrete until the support section of the support element is spaced from the upper side of the concrete panel (2) by a distance in the range of 0.5 cm to 3 cm, in particular in the range of 0.5 cm to 1.5 cm. The at least one displacement device can remain spaced apart from the reinforcement. In particular, as already mentioned above, the displacement device may advantageously have a circumferential collar, wherein the collar is arranged relative to the bearing section of the bearing element in such a way that the bearing section of the bearing element has a distance to the upper side of the concrete panel in the range of 0.5 cm to 3 cm, in particular in the range of 0.5 cm to 1.5 cm, when the collar rests on the upper side of the concrete panel. This facilitates precise pressing in of the at least one displacement device and prevents unwanted sinking of the pressed-in displacement device. In particular, this method also allows the advantageous use of a programmable automatic movement device, in particular an industrial robot, to position the displacement devices. This achieves a high degree of accuracy, which is important in order to be able to lay the required reinforcing bars in the required manner later on, after the finished element plate has been installed on the construction site.

Particularly advantageous is a method for manufacturing a concrete component, in particular a concrete slab or a concrete wall, using several (in particular, directly adjacent) element plates according to the invention, in which reinforcing bars are inserted across the element plates, running through the grooves, before the space above the element plates is filled with liquid
 5 cast-in-place concrete.

According to an independent inventive concept, which can be implemented alone or in combination with one of the other features described in this application, an element plate for producing a semi-precast floor slab is particularly advantageous, comprising a reinforced
 10 concrete panel from whose upper side at least one displacement device protrudes, which has at least one hollow vessel, whose vessel opening is arranged in the concrete panel and is closed by the concrete of the concrete panel, wherein at least one support element with a support section arranged outside the concrete panel for supporting a reinforcing bar is arranged on the outside of the hollow vessel, wherein the support section has a distance from the upper side of
 15 the concrete panel in the range of 0.5 cm to 3 cm, in particular in the range from 0.5 cm to 1.5 cm.

The invention is shown schematically in the drawing as an example and is described below with reference to the figures, whereby identical or similarly functioning elements are usually given the
 20 same reference symbols even in different embodiments. The figures show:

Fig. 1 a first embodiment of an element plate according to the invention,
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Fig. 2 a detailed view of the first embodiment of an element plate according to the invention,

Fig. 3 an embodiment of a displacement device for an element plate according to the invention in a perspective view from above,
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Fig. 4 the embodiment of a displacement device for an element plate according to the invention in a top view from above,

Fig. 5 the embodiment of a displacement device for an element plate according to the invention in a side view,
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Fig. 6 the embodiment of a displacement device for an element plate according to the invention in another side view,

Fig. 7 an embodiment of a displacement device for an element plate according to the invention in a perspective view from below,

5 Fig. 8 a further detailed view of the first embodiment of an element plate according to the invention,

Fig. 9 a further detailed view of the first embodiment of an element plate according to the invention,

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Fig. 10 an embodiment of a semi-precast floor slab made of element plates according to the invention,

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Fig. 11 a detailed view of the embodiment of a semi-precast floor slab made of element plates according to the invention in a perspective view,

Fig. 12 a further detailed view of the embodiment of a semi-precast floor slab made of element plates according to the invention with a reinforcement bar placed on top,

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Fig. 13 a further embodiment of a displacement device for an element plate according to the invention in a sectional view,

Fig. 14 the further embodiment of a displacement device for an element plate according to the invention in a top view from above,

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Fig. 15 a detailed view of a second embodiment of an element plate according to the invention,

Fig. 16 a detailed view of the second embodiment of an element plate according to the invention with reinforcement bars applied, shown in section,

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Fig. 17 a detailed view of the second embodiment of an element plate according to the invention with reinforcement bars applied, shown in plan view from above,

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Fig. 18 the second embodiment of an element plate according to the invention in a top view from above,

Fig. 19 an embodiment of a semi-precast floor slab made of element plates according to the

invention in accordance with the second embodiment with reinforcement bars laid on top in a top view from above,

5 Fig. 20 a representation illustrating a possible method for manufacturing an element plate according to the invention,

Fig. 21 a representation illustrating another possible method for manufacturing an element plate according to the invention,

10 Fig. 22 a further embodiment of a displacement device for an element plate according to the invention in a perspective view from below,

Fig. 23 the further embodiment of a displacement device for an element plate according to the invention in a top view from above,

15 Fig. 24 the further embodiment of a displacement device for an element plate according to the invention in a side view,

20 Fig. 25 the further embodiment of a displacement device for an element plate according to the invention in a further side view,

Fig. 26 the further embodiment of a displacement device for an element plate according to the invention in a perspective view from above,

25 Fig. 27 a further embodiment of an element plate according to the invention.

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Fig. 1 shows a first embodiment of an element plate 1 according to the invention for producing a semi-precast floor slab. The element plate 1 has a reinforced concrete panel 2, from the upper side of which displacement devices 3 protrude, each of which has two hollow vessels 4, wherein the vessel openings 5 of the hollow vessels 4 are arranged in the concrete panel 2 and are closed by the concrete of the concrete panel 2, which can be seen in detail in Figures 2 and 8 in particular.

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The concrete panel 2 has an element plate length 23 along a longitudinal extension direction and an element plate width 24 along a transverse direction perpendicular to the longitudinal extension direction, wherein the element plate length 23 is greater than the element plate width 24.

The element plate has several longitudinal reinforcing bars 22 running in the longitudinal extension direction. The longitudinal reinforcing bars 22 are spaced apart from the upper side of the concrete panel 2 and arranged parallel to the upper side 10 of the concrete panel 2. In this way, a particularly high stability and rigidity of the concrete component to be manufactured is achieved.

Between adjacent hollow vessels 4, a groove 14 extending in the transverse direction is formed in each case, into which a reinforcing bar 8 can be inserted in the transverse direction in such a way that it protrudes laterally beyond the concrete panel 2. For the sake of clarity, only two reinforcing bars 8 are shown in the figure. Preferably, when manufacturing a semi-finished slab, a reinforcing bar 8 is inserted into each groove 14 across the element plates.

The grooves 14 are designed and arranged in such a way that the reinforcing bars 8 can be inserted at regular intervals so that one reinforcing bar 8 is arranged in each groove 14 in the transverse direction and adjacent reinforcing bars 8 are spaced 40 cm or less apart, in particular 20 cm.

Support elements 6 with a support section 7 arranged outside the concrete panel 2 for supporting a reinforcing bar 8 (not shown in Figure 1) can be arranged on the outside of each of the hollow vessels 4. The support section 7 may have a distance 9 from the upper side 10 of the concrete panel 2 in the range of 0.5 cm to 3 cm, in particular in the range of 0.5 cm to 1.5 cm, which is shown in detail in Figure 2 in particular.

The displacement devices 3 are of identical design and are arranged in several straight rows parallel to each other.

Reinforcing elements 11, which are also designed as lattice girders, protrude from the concrete panel 2 between the parallel rows of displacement devices 3 from the upper side 10 of the concrete panel 2. The longitudinal reinforcing bars 22 are attached to the free ends of the reinforcing elements 11.

Fig. 2 shows a detailed view of the first embodiment of an element plate according to the

invention, with the concrete panel 2 shown in section.

5 The wall of each hollow vessel 4 has a vessel opening edge 12 which surrounds the vessel opening 5 and is embedded in the concrete panel 2. This anchors each hollow vessel 4 securely and inseparably in the concrete panel 2.

10 The vessel opening edge 12 is bounded at the top by a circumferential collar 13 arranged on the outside of the displacement device 3, which rests on the top side 10 of the concrete panel 2.

15 The two hollow vessels 4 of each displacement device 3 are connected to each other by means of support elements 7, with a groove 14 being formed between the hollow vessels 4 of each displacement device 3. The groove 14 can advantageously have a width 15 in the range of 3 cm to 10 cm, in particular in the range of 3 cm to 7 cm or in the range of 6 to 8 cm, in particular 5 cm, in the area of the support elements 7.

20 The distance 16 between immediately adjacent displacement devices 3 in a row, which defines the width 15 of the groove formed between them, can advantageously be in the range of 3 cm to 10 cm, in particular in the range of 3 cm to 7 cm or in the range of 6 to 8 cm, in particular 5 cm.

25 The displacement devices 3 are therefore designed and arranged in such a way that reinforcing bars 8 (not shown in this figure) can be placed on the support elements 6 at a distance 17 of 40 cm or less, in particular 30 cm or less, or in the range of 15 to 30 cm or in the range of 20 cm to 25 cm, and in particular at a distance 17 of 20 cm, can be placed on the support elements 6.

30 Spacers 18 are arranged on the upper side of each hollow vessel 4. The spacers 18 are designed in the form of ribs. Further reinforcements (not shown in the figures), in particular reinforcing bars or reinforcing mats, can be placed on the spacers 18 on the construction site before a concreting process, whereby the spacers 18 prevent direct contact between the further reinforcement and the walls of the hollow vessels 4.

35 Figures 3 to 7 show an embodiment of a displacement device 3 for the first embodiment of an element plate 1 according to the invention in various views. The displacement device 3 is preferably manufactured as a one-piece plastic injection molded part.

Fig. 8 shows a further detailed view of the first embodiment of an element plate 1 according to the invention, wherein the concrete panel 2 is shown in section. It can be seen that the wall of

each hollow vessel 4 has a vessel opening edge 12 which surrounds the vessel opening 5 and is arranged in the concrete panel 2, whereby each hollow vessel 4 is securely and inseparably anchored in the concrete panel 2, which can be seen particularly well in the further detailed view of Figure 9. Figure 8 also shows reinforcing bars 8 placed on the support elements 6.

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Figures 10 and 11 show an embodiment of a semi-precast floor slab comprising several element plates 1 according to the first embodiment, wherein reinforcing bars 8 are placed across the element plates and parallel to each other on support sections 7 of the displacement devices 3 of immediately adjacent element plates 1.

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Fig. 12 shows a further detailed view of the embodiment of a semi-precast floor slab made of element plates 1 according to the invention. Figure 12 shows a reinforcing bar 8 placed in the groove 14 on the support sections 7 of the support elements 6, which connect the hollow vessels 4 to each other.

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Figures 13 and 14 schematically show another embodiment of a displacement device 3 for an element plate 1 according to the invention in a sectional view. The displacement device 3 has two hollow vessels 4 which are connected to each other by means of several support elements 6, with a groove 14 being formed between the hollow vessels 4 of each displacement device 3.

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Fig. 15 shows a detailed view of a second embodiment of an element plate 1 according to the invention, which has several of the displacement devices 3 shown in Figs. 14 and 15, wherein the support section has a distance 9 from the upper side of the concrete panel in the range of 0.5 cm to 3 cm, in particular in the range of 0.5 cm to 1.5 cm.

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The displacement devices 3 are designed and arranged in such a way that reinforcing bars 8 (not shown in this figure) can be placed at a distance of 40 cm or less, in particular at a distance 17 of 30 cm or less or at a distance 17 in the range of 15 to 30 cm, in particular in the range of 20 cm to 25 cm, and in particular at a distance 17 of 20 cm or 20 cm, as shown in Figure 16.

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A reinforcement 19 is arranged in the concrete panel 2. Further reinforcements (not shown in Figures 15 to 21) may be present, in particular reinforcements that protrude from the upper side 10 of the concrete panel 2.

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Fig. 17 shows a detailed view of the second embodiment of an element plate 1 according to the invention with reinforcement bars 8 placed on it, as seen from above.

It can be seen (see, for example, the area within the dashed circle) that the outwardly directed

support elements 6 of the displacement devices 3 are longer than half the distance between immediately adjacent displacement devices 3. It can also be seen (see, for example, the area within the dashed circle) that these outwardly directed support elements 6 of the displacement devices 3 are arranged in such a way, in particular off-center, that the support elements 6 of immediately adjacent displacement devices 3 of the same row do not interfere with each other spatially, but are arranged offset from each other. The reinforcing bars 8 running between the displacement devices 3 therefore rest simultaneously on the support elements 6 of both immediately adjacent displacement devices 3.

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Fig. 18 shows the second embodiment of an element plate 1 according to the invention in a top view from above. The element plate 1 has several identical displacement devices 3, which are arranged in several straight rows parallel to each other.

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Fig. 19 shows an embodiment of a semi-precast floor slab made of element plates 1 according to the second embodiment with reinforcement bars 8 laid across the element plates on support sections 7 in a top view from above.

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Fig. 20 shows an illustration of one possibility for manufacturing an element plate 1 according to the invention.

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The element plate 1 can be manufactured, for example, by arranging at least one reinforcement 19 in a formwork 20 and placing the displacement devices 3 on the reinforcement 19 with the vessel opening 5 facing the reinforcement in such a way that the vessel opening edge 12 is in direct contact with the reinforcement 19. The concrete panel 2 is then concreted by pouring in liquid concrete, whereby so much liquid concrete is poured into the formwork 20 until the vessel opening edge 12 is surrounded by concrete. The hollow vessels 4 each have a circumferential collar 13 which marks the upper end region of the vessel opening edge 12 and up to which (not shown in Figure 20) liquid concrete is poured into the formwork 20 to produce the concrete panel 2. The displacement devices 3 can be placed in particular by means of a programmable motion machine (not shown in Figure 21), in particular by means of an industrial robot.

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Figure 21 shows an illustration of another possible method for manufacturing an element plate 1 according to the invention.

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In the other method, the element plate 1 according to the invention is manufactured in such a way that at least one reinforcement 19 is arranged in a formwork 20 and the formwork 20 is then filled with liquid concrete 21. Several displacement devices 3 are then pressed into the concrete

21, which has not yet hardened, until their vessel openings 5 are positioned in the concrete 21 and sealed by the concrete 21, and the support sections 7 of the support elements 6 are spaced from the upper side 10 of the concrete 21 by a distance in the range of 0.5 cm to 3 cm, in particular in the range of 0.5 cm to 1.5 cm.

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The displacement devices 3 have a circumferential collar, wherein the collar 6 is arranged relative to the bearing section 7 of the bearing element 6 in such a way that the bearing section 7 of the bearing element 6 has a vertical distance from the underside of the collar 13 in the range of 0.5 cm to 3 cm, in particular in the range from 0.5 cm to 1.5 cm. This embodiment makes it possible to easily push the displacement devices 3 into the liquid concrete until the collar 13 comes into contact with the upper side 10 of the concrete 21.

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In particular, this method also allows for the advantageous use of a programmable automatic movement device (not shown in Figure 21), in particular an industrial robot, which positions the displacement devices 3.

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Figures 22 to 26 show a further embodiment of a displacement device 3 for an element plate 1 according to the invention in various views. The displacement device 3 is preferably manufactured as a one-piece plastic injection molded part.

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Figure 2 shows a further embodiment of an element plate 1 according to the invention.

The element plate 1 has three different areas 27, 28, 29.

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First displacement devices 25 are arranged in the first area 27. Second displacement devices 26 are arranged in the second area 28, which differ from the first displacement devices 25 in terms of their shape and/or their size and/or their volume. The first displacement devices 25 have a larger volume than the second displacement devices 26. As a result, smaller displacement devices 25 with a lower displacement volume are arranged in the second areas 26 of the element plate 1, in which a greater load is to be expected in the concrete component to be manufactured, while larger displacement devices 26 with a greater displacement volume are arranged in the first areas of the element plate 1, in which a lower load is to be expected in the concrete component to be produced. In this way, it is advantageously achieved that the concrete component has more concrete in the second area of greater load than in the first areas 25 of lower load.

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The third area 29 of the element plate 1 is free of displacement devices 25, 26, although it is large enough that displacement devices as large as the first and second displacement devices

25, 26 could be arranged there. This has the advantage that the concrete component to be manufactured has the maximum possible amount of concrete in the third area and therefore has particularly high stability and/or load-bearing capacity there.

Bezugszeichenliste:

	1	element plate
	2	concrete panel
5	3	displacement device
	4	hollow vessel
	5	vessel opening
	6	support element
	7	support section
10	8	reinforcing bar
	9	distance
	10	upper side
	11	lattice girder
	12	vessel opening edge
15	13	collar
	14	groove
	15	width
	16	distance
	17	distance
20	18	spacer
	19	reinforcement
	20	formwork
	21	liquid concrete
	22	longitudinal reinforcement bar
25	23	element plate length
	24	element plate width
	25	first displacement device
	26	second displacement device
	27	first area
30	28	second area
	29	third area

Patent Claims

1. Element plate (1) for producing a semi-precast floor slab, comprising a reinforced concrete panel (2) which has an element panel length (23) along a longitudinal extension direction and an element panel width (24) along a transverse direction perpendicular to the longitudinal extension direction, and from whose upper side (10) protrude a plurality of displacement devices (3), each of which has at least one hollow vessel (4) whose vessel opening (5) is arranged in the concrete panel (2) and whose vessel opening (5) is closed by the concrete of the concrete panel (2), wherein the element plate (1) has a plurality of longitudinal reinforcing bars (22) extending in the longitudinal extension direction, which are arranged at a distance from the upper side (10) of the concrete panel (2), characterized in that in each case a groove (14) extending in the transverse direction is formed between adjacent hollow vessels (4), into which a reinforcing bar (8) can be inserted in the transverse direction in such a way that it protrudes laterally beyond the concrete panel (2).
2. Element plate (1) according to claim 1, characterized in that the grooves (14) are designed and arranged in such a way that several reinforcing bars (8) can be inserted at equal distances so that a reinforcing bar (8) is arranged in each groove (14) in the transverse direction and adjacent reinforcing bars (8) have a distance (17) of 40 cm or less, in particular a distance (17) of 30 cm or less, or a distance (17) in the range of 15 to 30 cm, or in the range of 20 cm to 25 cm, or of 20 cm.
3. Element plate (1) according to claim 1 or 2, characterized in that the grooves (14) each have a width (15) in the range of 3 cm to 10 cm, in particular in the range of 3 cm to 7 cm or in the range of 6 cm to 8 cm or of 5 cm.
4. Element plate (1) according to one of claims 1 to 3, characterized in that the longitudinal reinforcement bars (22) running in the longitudinal extension direction are arranged parallel to the upper side (10) of the concrete panel (2).
5. Element plate (1) according to one of claims 1 to 4, characterized in that
 - a. reinforcement elements (11), in particular in the form of lattice girders, protrude from the concrete panel 2, to which the longitudinal reinforcement bars (22) are attached, or that
 - b. reinforcement elements (11), in particular in the form of lattice girders, protrude from the concrete panel 2, to the free ends of which the longitudinal reinforcement bars (22) are attached.

6. Element plate (1) according to claim 5, characterized in that the reinforcement elements (11) are arranged in several straight and mutually parallel rows and that one of the longitudinal reinforcement bars (22) is attached to each of the reinforcement elements (11) in a row.
- 5 7. Element plate (1) according to claim 6, characterized in that at least one row of reinforcement elements (11) runs between each two straight and parallel rows of displacement devices (3).
8. Element plate (1) according to one of claims 1 to 7, characterized in that
 - a. the longitudinal reinforcement bars (22) extend over the entire length of the element plate, or that a longitudinal reinforcement bar length of the longitudinal reinforcement bars (22) is 0.8 to 1.0 times, in particular 0.9 to 1.0 times, the length of the element plate, and/or that
 - b. the element plate length (23) is greater than the element plate width (24).
- 10 9. Element plate (1) according to one of claims 1 to 8, characterized in that on the outside of at least one of respectively two adjacent concave vessels (4) at least one support element (6) with a support section (7) is arranged, wherein the support section (7) has a distance (9) from the upper side (10) of the concrete panel (2) in the range of 0.5 cm to 3 cm, in particular in the range from 0.5 cm to 1.5 cm.
- 15 10. Element plate (1) according to claim 9, characterized in that the support element (6) is elongated and/or that the support element (6) is designed as a support bar, in particular a cylindrical support bar.
- 20 11. Element plate (1) according to claim 9 or 10, characterized in that the support section (7) has a concave shape and/or is designed to be concavely curved.
- 25 12. Element plate (1) according to one of claims 9 to 11, characterized in that the at least one support element (6) and the hollow vessel (4) are manufactured together in one piece, in particular by injection molding.
- 30 13. Element plate (1) according to one of claims 1 to 12, characterized in that at least one section of the wall of each hollow vessel (4), in particular at least one of the hollow vessels (4), is curved and/or that the wall of each hollow vessel (4), in particular at least one of the hollow vessels (4), has a curved section, in particular a circular section, in a horizontal cross-sectional plane.
14. Element plate (1) according to one of claims 1 to 13, characterized in that the wall of each hollow vessel (4), in particular at least one of the hollow vessels (4), has at least one flat section.

15. Element plate (1) according to claim 14, characterized in that the flat section is arranged at an angle of 70 degrees to 90 degrees to the upper side (10) of the concrete panel (2).
- 5 16. Element plate (1) according to one of claims 1 to 15, characterized in that the wall of each hollow vessel (4), in particular at least one of the hollow vessels (4), has a section parallel to the upper side (10) of the concrete panel (2).
17. Element plate (1) according to one of claims 1 to 16, characterized in that a section of the wall of each hollow vessel (4), in particular at least one of the hollow vessels (4), has the shape of a spherical segment.
- 10 18. Element plate (1) according to one of claims 1 to 17, characterized in that at least one spacer, in particular a rib-shaped and/or web-shaped spacer, is arranged on the upper side of each hollow vessel (4), in particular at least one of the hollow vessels (4).
19. Element plate (1) according to one of claims 9 to 18, characterized in that
 - 15 a. the support element (6) is shorter in one direction, in particular vertically, away from the wall of the hollow vessel (4) than the length and width of the vessel opening (5), and/or that
 - b. the support element (6) is longer in a direction, in particular perpendicular, away from the wall of the hollow vessel (4) than half the distance between immediately adjacent displacement devices (3).
- 20 20. Element plate (1) according to one of claims 9 to 19, characterized in that the support element (6) protrudes, in particular perpendicularly, from the wall of the hollow vessel (4).
21. Element plate (1) according to one of claims 9 to 20, characterized in that several support elements (6) are arranged on the outside of the hollow vessel (4), which protrude in different directions, in particular in opposite directions from the wall of the hollow vessel (4).
- 25 22. Element plate (1) according to one of claims 1 to 21, characterized in that each hollow vessel (4), in particular at least one of the hollow vessels (4), has a vessel opening edge (12) which is arranged in the concrete panel (2).
23. Element plate (1) according to claim 22, characterized in that the vessel opening edge (12) protrudes in the concrete panel (2) in direct contact with a reinforcement.
- 30 24. Element plate (1) according to claim 23, characterized in that the vessel opening edge (12) has a height in the vertical direction in the range from 0.5 cm to 3 cm.
25. Element plate (1) according to any one of claims 1 to 24, characterized in that each hollow vessel (4), in particular at least one of the hollow vessels (4), and/or each

displacement device (3), in particular at least one of the displacement devices (3), has a circumferential collar (13).

26. Element plate (1) according to claim 25, characterized in that the collar (13) rests on the upper side (10) of the concrete panel (2).

5 27. Element plate (1) according to claim 25 or 26, characterized in that the collar (13) has a width in the range of 0.5 cm to 2 cm.

28. Element plate (1) according to one of claims 1 to 27, characterized in that each displacement device (3), in particular at least one of the displacement devices (3), has one, in particular exactly one, further hollow vessel (4), and that the hollow vessel (4) and the further hollow vessel (4) are connected to each other by means of the at least one support element.

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29. Element plate (1) according to claim 28, characterized in that the at least one support element (6) and the hollow vessel (4) and the further hollow vessel (4) are manufactured together in one piece, in particular by injection molding.

15 30. Element plate (1) according to claim 28 or 29, characterized in that the hollow vessel (4) and the further hollow vessel (4) are connected to each other by means of a plurality of support elements (6).

31. Element plate (1) according to one of claims 28 to 30, characterized in that at least two of the support elements (6) are of identical design and/or are arranged parallel to each other.

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32. Element plate (1) according to one of claims 9 to 31, characterized in that the support section (7) of each of the support elements (6) has a distance from the upper side (10) of the concrete panel (2) in the range of 0 cm to 3 cm.

33. Element plate (1) according to one of claims 28 to 32, characterized in that one of the grooves (14) is formed between the hollow vessel (4) and the further hollow vessel (4).

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34. Element plate (1) according to claim 33, characterized in that the groove (14) is formed partly by a, in particular, flat outer wall of the hollow vessel (4) and partly by a, in particular, flat outer wall of the further hollow vessel (4).

35. Element plate (1) according to claim 33 or 34, characterized in that the outer walls of the hollow vessel (4) and the further hollow vessel (4), which form part of the groove, are arranged in planes that form an angle in the range from 0 degrees to 30 degrees to each other.

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36. Element plate (1) according to one of claims 28 to 35, characterized in that the element plate (1) has at least one of the following features:

- a. the hollow vessel (4) and the further hollow vessel (4) are of identical design,
 - b. the hollow vessel (4) and the further hollow vessel (4) are of identical size,
 - c. the hollow vessel (4) and the further hollow vessel (4) have the same shape.
- 5 37. Element plate (1) according to one of claims 28 to 36, characterized in that the hollow vessel (4) and the further hollow vessel (4) are designed and arranged to be mirror-symmetrical to each other.
38. Element plate (1) according to one of claims 28 to 37, characterized in that the vessel opening (5) of the further hollow vessel (4) is arranged in the concrete panel (2) and is closed by the concrete of the concrete panel (2).
- 10 39. Element plate (1) according to one of claims 28 to 38, characterized in that the vessel openings of the hollow vessel (4) and the further hollow vessel (4) are arranged completely in a common plane.
40. Element plate (1) according to one of claims 1 to 39, characterized in that the space above the at least one support element is free.
- 15 41. Element plate (1) according to one of claims 1 to 38, characterized in that the plurality of displacement devices (3), in particular identical displacement devices (3), are arranged in a single, in particular straight, row.
- 20 42. Element plate (1) according to one of claims 1 to 39, characterized in that the distance between immediately adjacent displacement devices (3) in the row is in the range of 3 cm to 10 cm, in particular in the range of 3 cm to 7 cm or in the range of 6 cm to 8 cm, in particular 5 cm.
43. Element plate (1) according to one of claims 1 to 40, characterized in that the plurality of displacement devices (3), in particular identical displacement devices (3), are arranged in a plurality of rows that are parallel to each other, in particular straight rows.
- 25 44. Element plate (1) according to one of claims 9 to 43, characterized in that the displacement devices (3) are designed and arranged in such a way that the reinforcing bars (8) can be placed parallel to each other and at a distance of 40 cm or less, in particular 30 cm or less, or at a distance in the range of 15 to 30 cm, in particular in the range of 20 cm to 25 cm, and most particularly at a distance of 20 cm, on the support
- 30 sections (7).
45. Element plate (1) according to one of claims 9 to 43, characterized in that the element plate (1) has at least two displacement devices (3) which differ from each other in terms of their shape and/or their size and/or their volume.

46. Semi-precast floor slab comprising a plurality of element plates (1), in particular identical element plates (1), according to one of claims 1 to 45.
47. Semi-precast floor slab according to claim 46, characterized in that the element plates (1) are arranged relative to one another in such a way that reinforcing bars (8) can be inserted into the parallel grooves (14) of adjacent element plates (1).
48. Semi-precast floor slab according to claim 46 or 47, characterized in that the element plates (1) are arranged and their displacement devices (3) are designed and arranged in such a way that reinforcing bars (8) can be placed or are placed on support sections (7) of the displacement devices (3) of adjacent element plates (1) parallel to each other across the element plates at a distance of 40 cm or less, in particular at a distance in the range of 15 to 30 cm or from 20 cm to 25 cm or at a distance of 20 cm.
49. Concrete component, in particular concrete slab, comprising several element plates (1) according to one of claims 1 to 45 or a semi-precast floor slab according to one of claims 46 to 48, and/or which is manufactured using a plurality of element plates (1) according to one of claims 1 to 45 or using a semi-precast floor slab according to one of claims 46 to 48.
50. Method for manufacturing an element plate (1) according to one of claims 1 to 45, characterized in that
 - a. that at least one reinforcement (19) is arranged in a formwork, onto which the displacement devices (3) are placed in such a way that between each pair of adjacent hollow vessels (4) a groove (14) extending in the transverse direction is formed, into which a reinforcing bar (8) can be inserted in the transverse direction such that it protrudes laterally beyond the concrete panel (2), and that the formwork (20) is then filled with liquid concrete until the vessel opening (5) is located in the concrete and closed by the concrete, in particular until the support section (7) of the support element (6) has a distance (9) to the upper side (10) of the concrete panel (2) in the range of 0.5 cm to 3 cm, in particular in the range of 0.5 cm to 1.5 cm, or that
 - b. at least one reinforcement (19) is arranged in a formwork and the formwork (20) is then filled with liquid concrete, and that the displacement devices (3) are then arranged in such a way that, between each pair of adjacent hollow vessels (4), a groove (14) extending in the transverse direction is formed, into which a reinforcing bar (8) can be inserted in the transverse direction such that it protrudes laterally beyond the concrete panel (2), and are pressed into the not yet hardened concrete until the vessel opening (5) is located in the concrete and is closed by the concrete, in particular until the support section (7) of the support element (6) has a distance (9)

to the upper side (10) of the concrete panel (2) in the range of 0.5 cm to 3 cm, in particular in the range of 0.5 cm to 1.5 cm.

51. Method according to claim 50, characterized in that the displacement devices (3) are positioned by means of a robot.

5 52. Method for manufacturing a concrete component, in particular a concrete slab or a concrete wall, using several element plates (1) arranged in particular directly next to each other according to one of claims 1 to 45, characterized in that reinforcing bars are inserted across the element plates into the grooves (14) of the displacement devices (3), and that the space above the element plates (1) is then filled with liquid concrete.