

Gripping device for lifting building elements

The present invention relates to a gripping device for such plate-like building elements which are at least principally comprised of a non-loadable core portion and of a surface plate covering it on both sides, the spacing of the surface plates being accessible at least through one edge, the device comprising: a frame structure; an actuator extending through the frame and being rotatable relative to the frame; a gripping member to be brought into effect with the surface layer at one end of the actuator, and an operating element at the opposite end of the actuator for changing the operating state of the actuator.

A building element, to the lifting of which the device of the invention is applicable, may be formed of a resilient, plate-like core portion made of mineral wool fibres or some other similar insulation material, and generally of two surface plates attached to opposite surfaces of the core portion. Besides the above-mentioned mineral wool, the core portion may also be made of porous plastic or the like. The surface plate is generally a metal plate, such as a coated steel plate, although it is in principle possible for the surface plate to be some other kind of plate made of metal or composite material. Generally, the surface plate is attached to the core layer by using an adhesive, but the surface plates may naturally be adhered to each other also in some other way, such as by using suitable spacers so that it is not necessary to glue the surface plates to the core layer. In any case, one refers here to such a building element of light structure which has a resilient core layer and surface plates of at least so thin or resilient material that the element may not be gripped by pressing from its opposite outer surfaces without damaging the element or without causing traces which deteriorate its appearance. Such building elements have to be lifted cautiously, and conventional lifting elements of clamp jaw type may not be used for gripping without causing visible damages. For example, lifting elements gripping the planar faces of elements with suction pads have been developed for lifting these blocks which are in itself light. However, as the surfaces of the surface plates may be shaped non-smooth, gripping problems occur due to this and also due to other reasons.

The publication WO-93/20004 discloses a lifting device and method, with which the edge of a plate-like element is gripped from the edge bead of the surface layer extending over a part of the thickness of the resilient core portion. This method works well as it is, but first of all, it requires gripping members shaped according to

the edge bead in the building element and according to the edge bead in the lifting device, so that the device and method of the patent cannot be used for lifting a building element without an edge bead or, for example, a cut building element, but the edges of the elements always have to be shaped to correspond to the gripping members of the lifting device. Another problem is that when the insulation material between the surface plates is relatively slightly resilient, in other words hard, the insertion and rotation of the arm member may not be conducted in any other way but by leaving space for it on the edge of the element, which again may deteriorate the insulation ability of the structure or restrict its shaping.

10 The object of the invention is to remove the above stated drawbacks by providing a gripping device with which all types of buildings elements described above may be lifted and which, however, does not damage the element surface in the finished structure in a way deteriorating the appearance. The second object of the invention is to provide such a gripping device, which makes it possible to use different kinds of porous and light insulation materials in the core between the surface plates in the elements so that the insulation ability would not decrease because of the gripping device. The third object of the invention is to provide such a gripping device, with which it is possible, if required, to grip building elements of the type described above from any edge irrespective of the building element having a tongue and groove or not, and irrespective of the shape of the possible tongue and groove.

The problems described above may be eliminated and the objects defined above may be realised by the gripping device of the invention, characterised in what is defined in the characterising part of claim 1 and by the method of the invention, characterised in what is defined in the characterising part of claim 10.

25 For hiding the gripping traces, the gripping device of the invention grips the vertical side surface of the tongue portion of the tongue-and-groove joint of the building element, the element being left invisible inside the tongue-and-groove joint upon assembling. However, the gripping device may be used for lifting the building element also from other edge surfaces, because also they are vertical in the lifting position. The gripping traces are either covered under the joint profile of adjacent building elements or, when necessary, the gripping traces may be covered by a separate protective strip or in some other way. In itself, the gripping traces are very insignificant, and in most cases it is not necessary to cover them at all. For example, when the surface plate is a plastic-coated steel plate, the plastic coating usually stays completely unbroken, at most its possible glossiness decreases, and also this difference disappears in time compared with the rest of the surface. As the members

of the gripping device of the invention, which are pushed between the surface plates, have a small end face and a small side face causing turning resistance, they often protrude into several core layer materials of different types leaving to these at most notches of insignificant sizes which do not affect the insulation ability or which may easily be filled. A further advantage of the gripping device of the invention is that it may be used for gripping such a tongue-and-groove edge of a building element which does not have edge beads perpendicular to the outer surfaces of the element, or clearly transverse edge beads, and that it may also be used for gripping such an edge of a building element which merely has surface plates parallel to the outer surface of the element, and thus has no tongue and groove.

The gripping device is next described in more detail, referring to the enclosed drawings in which:

Fig. 1 shows the gripping device of the invention from below in direction I of Fig. 2;

Fig. 2 is a cross-sectional view of the gripping device of the invention with the gripping members in open position along plane II-II of Fig. 1. The building element of the figure has no edge bead;

Fig. 3 is a similar view to that of Fig. 2 of the gripping device of the invention with the one gripping member in open position and the second gripping member is closed. The building element of the figure has an edge bead, but the gripping device is not in contact with it;

Fig. 4 is a similar view to Figs. 2 and 3 of the gripping device of the invention with the gripping members closed. The building element of the figure has no edge bead in the tongue;

Fig. 5 shows the structure of the gripping device of Fig. 2 in more detail, presenting the other half of it in a similar view to Fig. 2 in larger scale and in connection of such a wall element, which has no edge bead;

Fig. 6 shows a gripping device of the invention with the gripping members closed and lifting a building element from its edge, the surface plates of the building element being parallel to the rest of the surface without any tongue-and-groove design or other similar design, partly in cross-section in a similar view to that of Fig. 4 and partly axonometrically;

Figs. 7A – 7C show on enlarged scale as a detail a gripping projection representing various embodiments of the invention and positions of the opposite gripping surface in the gripping position, in Fig. 7A in a similar view to that of Fig. 5, and of Figs. 7B – 7C in a similar view to that of Fig. 4.

- 5 The gripping device is used for lifting plate-like building elements 10, which at least principally consist of a porous and non-loadable core layer 11 and of a surface plate 12, 13 covering it on both sides, the spacing of the surface plates being accessible at least through one edge 14 of the building element; in other words, the surface plates do not at any rate cover this edge from the area of the gripping members 3 of the
- 10 gripping device to be described later. As already was mentioned at the beginning, the surface plates may be of plastic or of composite material, such as reinforced plastic, but generally a metal plate, such as an aluminium plate or a plastic-coated steel plate, is used as surface plates. The core layer is usually made of mineral wool, but it may also be made of expanded plastic, such as polystyrene or polyurethane,
- 15 etc. All these are porous, and their weight by volume is low. In these building elements 10, the core layer 11 is so light that it does not, at least not to a significant extent, carry the principally vertical forces caused by the weight of the building or the loads on the intermediate floors and/or roofs of the building and directed to the wall containing the elements or to the horizontal structure. The elements and their
- 20 core layers naturally have such strength and rigidity that they carry, for example, wind loads and other local forces caused by a.o. additional structural elements. The structural elements carrying the main loads of the building may be columns or beams between building elements, or columns, beams or lattices inside a building element, but because they have no connection to the gripping device of the
- 25 invention or its operation, they are not described in more detail. Mineral wool is a resilient material, foamed plastics again being only slightly resilient, i.e. rather hard, but as they are porous and have a small weight by volume, they may be relatively easily displaced by breaking them locally with gripping members 3 of the gripping device of the invention or, alternatively, with gripping projections 6. Typically, the
- 30 surface plates 12, 13 and the resilient core layer 11 are glued to each other, but when expanded plastic is concerned, it may have been foamed locally between the surface plates so that it grips directly onto the surface plates in connection with the polymerisation. The core layer works, for example, as thermal insulation and as the web of the element. The building elements are generally straight, i.e. planar, but the
- 35 surface plates 12, 13 are often shaped to comprise grooves, ridges or some other shapes both for stiffness and appearance purposes. These building elements may naturally also be curved or shaped in some other way in which case the gripping

device of the invention has to be dimensioned correspondingly. Irrespective of the shapes of the surface, all these elements are called plate-like in the specification and claims, because the distance W3 of the surface plates is substantially smaller than the other principal measures of the building element, i.e. length and width, and because the curvatures of the element correspond to the curvatures of the plates or other similar conventional folds or bends. When viewed in the installation position, there is a tongue at the upper edge 14 of the building element, and a groove at the lower edge for joining them tightly together. Because the gripping device of the invention may grip on any kind of edge 14 of a building element, i.e. also an edge 14 having straight surface plate edges, the various forms of tongues and grooves need not be explained here. It is due to the small or relatively small strength and/or hardness of the core layer 11 of the element and the very small thickness of the surface plates, for example, 0.5 mm – 5 mm, typically 1 mm – 2.5 mm, that no such gripping device which presses the element from opposite surface plates towards each other between heavy jaws, may be used for gripping such a light-structure building element.

The main parts of the gripping device comprise a rigid frame structure 1 and at least one actuator 2 extending through this frame structure and being rotatable relative to it. At one end of the actuator there is a gripping member 3 to be brought into effect with the surface layer, the opposite end having operating elements 4 for changing the operating state of the actuator 2 first into a free position V, in which the gripping device may be inserted against an edge 14 of the building element 10 so that the gripping members or gripping projections protrude between the surface plates, and in which the gripping device may correspondingly be separated from the element and, secondly, into a gripping position P, in which the gripping device is attached to the building element so that it carries the weight of the element. According to the invention, each gripping member 3 consists of a gripping surface 5, which is eccentric relative to the swivelling axis 17 of the actuator 2 and protruding outwards from the swivelling axis. The said gripping surface 5 is formed to the lower end of the swivelling axis 17, when viewed in the operating position of the device, with the shape of an eccentric 23, and the shape of the gripping surface 5 and/or of its sections 15a, 15b, 25a, 25b in a perpendicular plane to the swivelling axis may be an arc of a circle, part of an elliptical arc, part of an arc of a parabola or hyperbola, or some other shape for achieving a desired and controlled pressing against the surface of the surface plate 12, 13. When the swivelling axis 17 is turned in a plane perpendicular there to in directions R, the normal 22 of the gripping surface 5 turns, for example, between a position principally parallel to the surface plate 12 or 13, in

which the gripping surface 5 is in the free position V, and a position principally perpendicular to the surface plate 12 or 13, in which the gripping surface 5 is in the gripping position P, as can be seen in Fig. 1. The above normal directions of the surface are only indicative, and they may vary a lot in practice. The eccentrics 23
5 may be situated in the swivelling axis 17 either as fixed or changeable parts and attached in a suitable way so that they may be changed according to the thickness and/or shape of the building element to be lifted at a given time, when necessary.

According to the present invention, the frame structure 1 has fixed or adjustable or changeable gripping projections 6 at the place of the said gripping surfaces 5 turned
10 into the gripping position P. The gripping projections may be formed directly to the frame structure by machining, but preferably they are pins shown in the Figs., attached to the holes of the frame structure provided with threads 30 so that the protrusions may be adjusted when required and/or they may be changed according to the thickness and/or shape of the surface plate 12, 13 of the building element to
15 be lifted at a given time. In this way, the first minimum distance $W1a$ of the gripping projections 6 and the gripping surfaces 5 turned into the gripping position P, the said distance in each pair of gripping surfaces – gripping projections being the distance between the points extending most outwards, is always made suitable so that pressing is directed to the surface plate 12 or 13 between the gripping surfaces
20 and the gripping projections, enabling the lifting of the building element due to sufficient friction and/or slight and local deformation of the surface plate 12, 13, without damaging the surface plate or its possible coatings. The first minimum distance $W1a$ is smaller than the thickness S of the surface plate 12 or 13, and besides a positive value $+W1a$, it may also have a negative value $-W1a$, as is understood on the basis of Fig. 5 and especially of Fig. 7A; however, the marking
25 $W1a$ is generally used. As the gripping surfaces 5 are turned into the free position V, the second distance $W2$ between them and the gripping projections 6 is substantially bigger than the thickness S of the surface plate so that the surface plate 12, 13 fits between them and away again. This is a sufficient condition in the case
30 of Fig. 6, in which the surface plates are straight as far as to the edge 14. If the surface plates are inclined from the edge 14, as may be the situation with a tongue and groove and as is shown in Figs. 2 – 5, the second distance $W2$ between the gripping surfaces and the gripping projections 6 is substantially bigger than the measure $[D \times \tan \varphi + S]$, in which D is the distance from the edge 14 of the element
35 and/or surface plate, and the angle φ is the angle of tilt in relation to the rest of the surface plate area, i.e. a tongue-and-groove tilt.

The gripping surface 5 comprises a surface section or surface sections 15a, 15b and 25a, 25b, the side lines of which in planes passing through the centre line 31 of the swivelling axis 17 are effectively or, on an average, principally parallel to the surface plate 12, 13 in the area of the gripping point. According to the invention, the gripping point is formed by the surface plates in their vertical sides, viewed in the lifting position of the building element, and thus principally surface plate surfaces parallel to the element plane or possible curvature of the element, or side surfaces of the tongues and grooves deviating from the above mentioned element plane or curvature either only in the direction of the element thickness W3 - so that the directions of the surfaces to be gripped are principally parallel to the element plane or the possible curvature, only slightly closer to each other - and/or due to the above mentioned tongue-and-groove tilt ϕ - so that the directions of the surfaces to be gripped deviate from the said curvature or plane by the said angle. The tilts ϕ of the side surfaces of the tongues and grooves are at most 45° , but generally at most 30° , and typically between 5° and 15° . The possible edge fold 24 at the edge of the surface plate, whether with a tongue and groove or not, is of no use when using the gripping device of the invention, but it is of no damage either, so that it can be ignored. For indicating this, the edge 14 of the building element in Fig. 3 has straight edge folds pointing towards each other at the end of the tongue and groove, the eccentric 23 of the invention with its gripping surfaces having no contact with these edge folds during the gripping position P, the free position V, or the lifting. The edge 14 of the building elements in Figs. 2 and 4 as well as 6 has no such edge fold in which cases the gripping device of the invention works very well.

In a preferable embodiment of the invention, each gripping surface 5 comprises an arched groove 26, consisting of two convex surface sections 25a, 25b connected to each other and being principally horizontal in the operating position; in addition, it comprises supporting fillets 27, 28 on the upper and lower edges of the arched groove, both consisting of at least one convex surface section 15a, 15b. The curvatures are arcs of a circle, parts of arcs of parabolas or hyperbolas, or of some other shape in planes perpendicular to the centre line 31 of the swivelling axis so that the curvature centres or corresponding points may join this centre line 31 or be situated laterally thereof for achieving smooth transfer of the surface sections 15a, 15b, 25a, 25b from the free position V to the gripping position P against the inner surface 8 of the surface plate, in which gripping position at least some of the surface sections are pressed against the surface plate 12, 13. The gripping surface 5 is found at the outer end of the eccentric 23 or press arm attached to the swivelling axis, and it or its surface sections form substantial angles K1, K2, K3, K4 in relation to the

turning plane perpendicular to the swivelling axis 17, i.e. in planes passing through the centre line 31. Thus, the gripping surface 5 consists of surface sections 15a, 15b, 25a, 25b which are convex at least in one direction and which preferably are parts of cylindrical surfaces and/or parts of conical surfaces and/or parts convex in two directions, such as parts of ball segments. Typically, the surface sections 25a, 25b of the supporting fillets form angles relative to the thickness W3 of the surface plates 12, 13 and simultaneously relative to the swivelling axis 17 and the plane perpendicular to its centre line, the external acute angles K1, K2 being at least $45^\circ \pm \varphi$. The surface sections 25a, 25b of the arched groove 26 typically form angles to the plane perpendicular to the said centre line, the external acute angles K3, K4 being at most $60^\circ \pm \varphi$. These values are only indicative, and they may vary in wide ranges, depending on the material and thickness S of the surface plate 12, 13.

In a preferred embodiment of the invention, the gripping projection 6 comprises a point 16 protruding from the frame structure 1 towards the eccentric 23 or the pressing arm. The gripping projection 6 is placed so that the spacing of the gripping surfaces 5 turned into the gripping position P and the projection meets the following conditions. The point 16 of the gripping projection 6, which may be straight at its extreme end, i.e. V-shaped in the plane perpendicular to the travelling direction of the gripping surface 5 and parallel to the axis line 31, or rounded, such as a cone with a round tip, or of a similar shape not shown in the figures, extends at least into the area of the supporting fillets 27, 28 of the gripping surface 5, or between the surface sections 25a, 25b of the sides of the arched groove 26 so that the first maximum distance W1b of these surface sections 25a, 25b and the point 16 deviates from the line of the surface plate 12, 13 at this point. When the point 16 is at the junction of the bottom 29 of the arched groove 26, i.e. of its surface sections 25a, 25b, the first maximum distance W1b of the point 16 and the surface sections 25a, 25b of the arched groove is possibly equal to or, in practice, slightly bigger than the thickness S of the surface plate, but however so that, at the same time, the minimum distance W1a of the outermost points of the surface sections 15a, 15b of the supporting fillets 27, 28 and the point 16 is smaller than the thickness S of the surface plate, if the point 16 is outside the outermost points of the surface sections, i.e. the junction line of the supporting fillets 27 and 28, as can be seen in broken lines in Fig. 7A. If the point 16 is within the outermost points of the surface sections, i.e. between the surface sections 25a and 25b, the first minimum distance W1a is negative in which case the point 16 and the supporting fillets 27, 28 are interleaved, as can be seen in lines of dots and dashes in Fig. 7A. Normally, the angle between the surface sections 25a and 25b is larger than the angle of point of

the point of the gripping projection 6. Also in the embodiment in Figs. 4 and 7B – 7C, the first minimum distance $W1a$, which is the range measured perpendicular to the surface plates, is smaller than the thickness S of the surface plates 12, 13; but the shortest distance between the point surfaces 34a, 34b of the gripping point 6 and the surface sections 15a, 15b of the gripping surface 5, which is inclined relative to the plate plane and which is not shown in the figures, is however typically equal to the thickness S of the surface plate, or bigger. Thus, the thickness S of the surface plate is not pressed thinner between the gripping surface 5 and the gripping point 6, but these parts are found at different heights and moved towards an interleaving position to some extent, although not being interleaved, so that some kind of deformation takes place in the surface plate. Because in all embodiments, the first minimum distance $W1a$ always is smaller than the thickness S of the surface plate, so that the surface plate 12 or 13 will be deformed at least to some extent when turning the gripping device into its gripping position P , at least pre-pressing is achieved on the surface plate/surface plates, which in some cases may be sufficient for lifting the building element, depending on the friction between the surface plates 12, 13 and the gripping surface 5 and the gripping projection 6, respectively.

According to a special feature of the invention, the swivelling axis 17 has travel clearance H transverse to the thickness $W3$ of the element, preferably perpendicular, so that the bottom 29 of the arched groove 26 is able to move from the point 16 of the gripping projection at least to some part of the height $H2$ of the lower surface section 25b of the arched groove 26. Thus, as the surface plate 12, 13 has in the free position of the gripping surface first been brought between it and the point 16, and the gripping surface has then been turned in the direction of rotation R at the place of the point 16 to the gripping position P , the eccentric 23 or a corresponding member moves principally in the same direction T or T' , i.e. substantially downwards, due to the effect of weight G of the building element 10 affecting downwards and the pre-pressing. The downward movement may be, for example, rectilinear, as is shown with the reference T in Figs. 5, 7A and 7C, and it is generated with the help of the clearance $H1$ described above. The transition of the gripping surface 5 made possible by the said clearance has been shown in thin broken lines in Figs. 7A and 7C. The consequence is that the gripping projection 6 presses with its point 16 the intermediate surface plate against the upper surface section 25b of the arched groove 26 of the gripping surface 5, thus achieving a close self-tightening gripping between the surface plate 12, 13 and the gripping projection 6 and gripping member 3. Although the above-described arrangement appears to

shape the surface plate, in practice, it only leads to a completely or virtually invisible trace.

The gripping surfaces 15a, 15b in the embodiments of Figs. 3 – 4 and 7B – 7C and the gripping projection 6 are outwards convex in at least one direction and, most preferably form one surface combination convex in two directions, such as a surface convex in two directions corresponding to the shape of a part of a toroidal outer circumference. Also in this case, the gripping projection 6 has a point 16 which, as has been described in connection with the former embodiment, may be rounded, such as a cone with a round tip or the like, or alternatively, it may be V-shaped in the plane perpendicular to the travel direction of the gripping surface 5 and parallel to the axis line 31 so that it contains two point surfaces 34a and 34b forming an angle relative to each other. In addition, the gripping projection 6 and the gripping surface 5, i.e. their outermost points, are situated by the height H3 from each other in the vertical direction, i.e. parallel to the axis line 31. According to a special feature of the invention, the swivelling axis 17 has travel clearance H1 transverse to the thickness W3 of the element, preferably perpendicular, so that the gripping surface 5 and especially its lower surface section 15a is able to move towards the point 16 of the gripping projection. As the surface plate 12, 13 in the free position V of the gripping surface 5 has first been brought between it and thereafter the gripping surface 5 has been turned in the direction of rotation R to the point 16 of the gripping projection into the gripping position P, the eccentric 23 or a similar member moves principally to the same direction T because of weight G of the building element 10 affecting downwards and of the pre-pressing, thus pressing between the point to the surface plate and the gripping surface and possibly causing deformation to the surface plate, as has been described above. In the above embodiment, the eccentric 23 has to be at a certain distance H1 above the point. As another alternative, for example the gripping projection 6 and thus the point 16 may be arranged turnable and tiltable around a hinge line 36 perpendicular to the axis line 31 and parallel to the surface of the building element 10. In this case, as the surface plate 12, 13 in the free position V of the gripping surface 5 has first been brought between it and the point 16, and the gripping surface 5 has then been turned in the direction of rotation R into the gripping position P at the place of the point 16, the eccentric 23 or a similar member tilts mainly to the same direction with the turning movement T', due to weight G of the building element 10 affecting downwards and the pre-pressing, as has been shown in Fig. 7B. The transition of the gripping projection 6 made possible by this turning has been shown in thin broken lines in Fig. 7B. Although this arrangement described above appears to

shape the surface plate; in practice it only leads to a completely or virtually invisible trace.

In practice, the trace generated in all gripping positions P of the invention described above is completely or at least sufficiently invisible, as the gripping projection and the gripping surface leave only an elastic deformation to the surface plate 12, 13, but it is evident that the invention is not restricted to the elastic deformation only, although this is preferable, but according to the situation, the gripping surface and the gripping projection may also allow a plastic deformation to be made to the surface plate 12, 13. The character or general shape in principle of the elastic or plastic deformation made to the surface plate 12, 13 has been shown in dotted lines in Figs. 7A, 7B and 7C, the exact measure and shape of this deformation depending on the difference between the first minimum distance W1a and the first maximum distance W1b and on their relation to the thickness S of the surface plate. As the distance W3 and principal direction of the surface plates – i.e. the direction elsewhere as in the area of the gripping surface 5 and the gripping projection 6 – remains at least principally unchanged, the strength or the pre-pressing generates a sufficient friction or connection to the gripping surface/gripping projection so that the indeed small weight G of the building element 10 achieves self-tightening, in which the surface plate pulls the gripping surface 5 or gripping projection 6 a small distance T, T' with it, as it further simultaneously at least increases the elastic and/or plastic deformation at this place.

Indeed, the gripping device of the invention operates with one gripping member – gripping projection combination, but preferably it has at least two gripping member – gripping projection combinations 20a, 20b or 20c, 20d at a distance W4 from each other corresponding to the distance W3 of the surface plates and placed reversed in relation to the middle plane 7 of the element, as can clearly be seen in Fig. 1. The best lifting capacity and the lowest risk for damaging the element surface plates is achieved by using four gripping member – gripping projection combinations always in pairs so that in each pair two combinations lie at a gripping distance W4 from each other corresponding to the distance W3 of the surface plates and placed reversed, and the pairs lie at a distance E from each other in a direction parallel to the edge 14 of the element 10. The gripping distance W4 is either the distance of the surface plates, i.e. the thickness W3 of the element as the lifting edge is at least approximately straight without a tongue-and-groove shaping, as in Fig. 6, or smaller than this when the lifting edge 14 has a shaping generating a tongue, as in Figs. 2 – 5. In this case, the gripping distance $W4 \approx \{W3 - 2x[D \cdot \tan \varphi + Z]\}$, in

which D is the distance of the gripping point from the edge 14 of the element and/or the surface plate, Z is the measure of the possible step fold 32 of the surface plate in the direction of the element thickness W3, and the angle φ is the angle of tilt of the surface plate relative to the rest of the area of the surface place, i.e. the tongue-and-groove tilt. The thickness of the surface plate, the shaping of the gripping surfaces 5 and the gripping projection 6, and their planned positioning as well as the definition of the measuring point, and naturally the tolerances, cause the approximation in the above equation, but anyhow, the principle is distinct. The gripping member 3 with its gripping surfaces 5 has been shaped and arranged to project into the element through the edge 14 of the building element, i.e. typically in the principal direction of the surface plates of the element, into the material forming the core layer 11. This is possible as the core layer is made of resilient material enabling the eccentric 23 and its swivelling axis 17 to deviate the core layer material in front of them as the material yields. In fact, the resilience of the material of the core layer 11 does not have to be very high, as long as its density and thus its strength are sufficiently low so that the eccentric and the swivelling axis are able to locally break its own volume of core layer material, i.e. deviate it in front when pressing with a moderate force in the direction F. Because of this, the length L1 of the parts going between the surface plates 12, 13, i.e. the gripping projections 6 or preferably the gripping members 3, the thickness of the axis 17 included, is at most 45% of the smallest occurring gripping distance W4 of the surface plates 12, 13. With this, it is in this case attempted that the cross-section A1 of the eccentric 23 of the gripping members 3 in the direction of thickness of the element would be as small as possible in order to make the gripping members easily project into the core layer 11.

In principle, the gripping members, i.e. the eccentric 23 with its gripping surfaces 5 and swivelling axis 17 may be placed in the gripping device so that the gripping surface 5 will press against the outer surface 9 of the surface plates 12, 13, and the gripping projections 6 have been placed so that they project between the surface plates through the edge 14. It is however believed that the first mode of operation and structure in which the gripping surface of the gripping members press against the inner surface 8 of the surface plate and the gripping projection 6 has been arranged to come into contact with the outer surface 9 of the surface plate, is the most flexible when considering various situations of use.

The frame structure comprises two frame parts 1a, 1b, each one of which includes at least one gripping member – gripping projection combination 20a, 20c; 20b, 20d, and adjustable connection elements 18 connecting the frame parts with each other;

with these connection elements, the distance W4 of the gripping member – gripping projection combinations may be adjusted in direction of the element thickness to correspond to the predetermined distance $\{W3 - 2x[D \cdot \tan \varphi + Z]\}$ of the gripping points of the surface plates 12, 13. The connection elements may simply consist of a screw or bolt extending to both frame parts 1a and 1b and of a distance piece between the frame parts, the screw or bolt passing through the said distance piece, as is understood from the figures. The distance W4 is adjustable by changing the distance piece.

As is apparent from above, the gripping distance W4 of the gripping member – gripping projection combinations of the two frame parts 1a and 1b is adjusted to correspond to the distance of the surface plates 12, 13 of the building element or the area A2 at their edge, either in advance or in connection with the gripping process. According to the invention, the building element 10 is gripped at least from its one surface plate 12 and/or 13 by pressing a section of the surface plate substantially parallel to the building element between the gripping surface 5 and the gripping projection 6 of the gripping device. As the building element then is lifted upwards with the help of the gripping device, the surface plates move the said gripping surface 5 towards the gripping projection 6, or reversed, by the action of weight G of the building element and the pre-pressing directed to the surface plate/surface plates by the gripping member – gripping projection combination of the gripping device, increasing the pressing between these. A self-tightening mechanism is thus achieved between the gripping device and the surface plate/surface plates of the building element. After the building element has been lowered to the desired place, the building element is released by increasing the mutual distance between the gripping surface 5 and the gripping projection 6 to the predetermined second distance W2. Especially the gripping surfaces 5 and the gripping projections 6 are pressed substantially parallel to the building element to the section A2 of the surface plate, which is either parallel to the rest of the surface plate section or which, alternatively, forms a tongue-and-groove tilt φ of at most 30° , or between 5° and 15° in relation to the rest of the surface plate, as has already been mentioned before.

In a situation, in which the surface plates of the building element 10 to be lifted are made of such plastic or composite to which it is not possible to press a slight deformation without damage, a gripping projection 6 which has a tip portion 16 rounded with a considerably larger radius or including a larger plane area may be used, as is shown in Fig. 4. In this situation, also the gripping surface 5 comprises suitably formed straight or convex, but uniform surface sections 15a, 15b without

the arched groove described above for pressing against the opposite surfaces 8, 9 of the surface plate set between these.

5 The operating member 4 is a turning handle for rotating the actuator 2 only around such a swivelling axis 17, which is principally perpendicular to the distance W3 of the surface plates 12, 13 of the element. The operating member has no other function, and it is in no way necessary to lock it into the gripping position P during the lifting of the wall element 10.

10 For fastening the hoists of a lifting machine not shown in the figures, the frame structure 1 comprises suspension elements 9 separate from the actuators, such as loops or similar elements in the frame parts of the frame structure forming a fixed part of these. For making the lifting position of the building element 10 to be as desired, i.e. exactly vertical or tilted to a certain extent, it is possible in the first case to use both suspension elements 19 apparent in the figures, or in the second case, only either one of the two suspension elements so that the distance of the centre of gravity of the building element and the suspension element provides the building element with a slightly tilting moment. If required, the suspension elements may be made adjustable in the direction W3 of the element thickness. In addition, the gripping device may comprise a middle plane 7 of the element of the side support not shown in the figures, extending to a certain measure of the height of the building element 10 downwards from the frame structure 1 not shown in the figures on the same side as the used combination of gripping elements – gripping projections 20a and 20c or 20b and 20d, especially when the building element for some reason is gripped only from its other surface plate 12 or 13.

25 Especially for situations, in which the material of the core layer 11 is relatively hard, porous, but rather light plastic, but also when using mineral wool, the edges 33a, 33b of the eccentric 23 or the pressing arm may be formed suitably sharp in the plane perpendicular to the normal 22 of the gripping surface 5, i.e. knife-like, so that they cut into the material of the core layer and do not only push it in front of them when the swivelling axis 17 is rotated in directions R.



Claims

1. Gripping device for lifting such plate-like building elements (10) which at least principally consist of a non-loadable core layer (11) and of a surface plate (12, 13) covering it on both sides, the spacing between the plates being accessible through at least one edge (14) of the building element, the device comprising: a frame structure (1); an actuator (2) extending through the frame structure and rotatable in relation to it; at one end of the actuator a gripping member (3) to be brought into effect with the surface plate; and operating members (4) at the opposite end of the actuator (2) for changing the operating state of the actuator (2); characterised in that each gripping member (3) consists of a gripping surface (5) eccentric to the swivelling axis (17) of the actuator and extending to the side from the swivelling axis; that the frame structure (1) comprises gripping projections (6) at the place of the said gripping surfaces turned into gripping position (P); and that the first minimum distance (W1a) between the gripping projections (6) and the gripping surfaces (5) turned into the gripping position (P) at least causes pressing to the surface plate (12 or 13), and the second distance (W2) between the gripping projections (6) and the gripping surfaces (5) turned into free position (V) is substantially bigger than the thickness (S) of the surface plate.
2. Gripping device according to claim 1, characterised in that it comprises at least two gripping member – gripping projection combinations (20a, 20b or 20c, 20d) at a gripping distance (W4)) from each other corresponding to the distance between the surface plates (12, 13) of the element and reversed in relation to the middle plane (7) of the element; and that the gripping member (3) with its gripping surfaces (5) is arranged to project into the element through the edge (14) of the element and further against the inner surface (8) of the surface plate, and the gripping projection (6) is arranged to come into contact with the outer surface (9) of the surface plate.
3. Gripping device according to claim 1, characterised in that the gripping surface (5) is situated at the outer end of the eccentric (23) or a pressing arm attached to the swivelling axis forming substantial angles relative to the turning plane perpendicular to the swivelling axis; and that the gripping projection (6) comprises a point (16) protruding from the frame structure towards the eccentric (23) or the pressing arm, and the gripping surface (5) is formed of surface sections (15a, 15b, 25a, 25b) convex at least in one direction, said sections being preferably parts of cylindrical surfaces and/or conical surfaces and/or ball segments and forming the thickness (W3) of the element between the surface plates (12, 13) and



simultaneously angles (K1-K4) relative to the said turning plane, of which angles at least one is at least 45°.

4. Gripping device of claim 1 or 3, characterised in that each gripping surface (5) comprises an arched groove (26), consisting of two convex surface sections (25a, 25b) connected to each other and being mainly horizontal in the operating position, and supporting fillets (27, 28) at the upper and lower edges of the arched groove, both fillets being formed of at least one convex surface section (15a, 15b).
5. Gripping device of claim 3 or 4, characterised in that the point (16) of the gripping projection (6) is at most at such a first maximum distance (W1b) from the bottom of the surface sections (25a, 25b) of the sides of the arched groove (26) of the gripping surface (5), or the point surfaces (34a, 34b) of the gripping projection (6) are at most at such a first minimum distance (W1a) from the surface sections (15a, 15b) of the gripping surface (5), the location of which distance deviates from the line of the surface plate (12, 13) at this place.
6. Gripping device according to one of the claims 3 – 5, characterised in that the swivelling axis (17) has a travel clearance (H) transverse to the thickness (W3) of the element, preferably perpendicular there to, so that the bottom (29) of the arched groove (26) can move from the point (16) of the gripping projection to at least some part of the height (H2) of the lower surface section (25b) of the arched groove (26).
7. Gripping device according to claim 2, characterised in that the frame structure comprises two frame parts (1a, 1b), each including at least one gripping member – gripping projection combination (20a, 20c; 20b, 20d), and adjustable connection elements (18) joining the frame parts to each other, the gripping distance (W4) of the gripping member – gripping projection combinations of the frame parts being adjustable by means of said connection elements in the direction of the element thickness to correspond to the predetermined gripping points of the surface plates (12, 13).
8. Gripping device according to claim 1, characterised in that the operating member (4) is a turning handle for rotating the actuator around only such a swivelling axis (17), which is principally perpendicular to the thickness (W3) of the element; and that the frame structure (1) comprises suspension elements (19) separate from the operating members for the lifting operation.
9. Gripping device according to claim 1, characterised in that the length (L1) of the parts going between the surface plates (12, 13) of the building element (10),



either gripping projections (6) or preferably gripping members (3), the thickness of the axis (17) included, is at most 45% of the smallest occurring gripping distance (W4) of the surface plates, in the direction of thickness of the element.

5 10. Method for lifting such plate-like building elements (10), which at least mainly consist of a non-loadable core layer (11) and a surface plate (12, 13) covering it on both sides, the spacing between the plates being accessible at least through one edge (14) of the building element, in which method the building element is carried by means of the said surface plates, characterised in that it comprises the following stages:

- 10 - the building elements (10) are gripped from at least one surface plate (12 and/or 13) by pressing a section of the surface plate substantially parallel to the building element between a gripping surface (5) and a gripping projection (6) a the gripping device;
- 15 - lifting the building element upwards with the gripping device so that the surface plate moves the gripping surface towards the gripping projection due to the weight (G) of the building element, thus increasing the pressing inbetween; and
- releasing the building element by increasing the mutual distance between the gripping surface (5) and the gripping projection (6) to a predetermined second distance (W2).
- 20 11. Method according to claim 10, characterised in that an area (A2) at the edge of the said element is used as the section of the surface plate parallel to the building element, the area:
- being either substantially parallel to the rest of the surface plate; or alternatively
- 25 - forming at most a tongue-and-groove tilt (φ) relative to the rest of the surface plate, the tilt being at most 30°, or between 5° and 15°.

12. Method according to claim 10, characterised in that before gripping the element, the gripping distance (W4) of the gripping member – gripping projection combinations of the two frame parts (1a, 1b) of the gripping device is set to

30 correspond to the distance between the surface plates (12, 13) of the building element in question or between the areas (A2) at the edge of the plates.