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Fixing element having an expander element

The invention relates to a fixing element having retaining means arranged at its rear end for clamping an article, according to the preamble of Claim 1.

DE-OS 29 14 739 discloses a fixing element which in the region of its leading end face has an expansion zone which is formed by a longitudinal slot having a base which slopes up towards the leading end and an expander element inserted in the longitudinal slot. Anchoring of such a fixing element is effected such that, after driving the shank into a hole pre-drilled in a building component, as the article to be fixed is being clamped to the building component the shank is displaced axially with respect to the expander element which digs into wall of the drilled hole. By virtue of the fact that the base of the longitudinal slot receiving the expander element slopes upwards, the expander element is pressed radially outwards and the fixing element is consequently wedged in the drilled hole. The disadvantage of the known fixing element, however, is that the expander element has teeth on its external surface which form straight edges projecting beyond the shank transversely to the longitudinal direction. These edges taking up the entire width of the expander element present a high resistance as the fixing element is being driven into the building component; in particular in the case of a building component

consisting of concrete, in addition to the high resistance to driving which is not conducive to easy assembly, this resistance can result in damage to the fixing element which impairs the anchoring function. Moreover, the expander element scrapes material from the inner wall of the drilled hole during the driving-in operation. That material collects in the longitudinal slot and may possibly lead to the expander element's becoming jammed in the longitudinal slot. This causes the displaceability of the expander element in the longitudinal slot to be impaired to such an extent that subsequent expansion after the anchoring operation, in the event that the drilled hole widens as a result of cracks forming, is not possible. Because of this drawback, the known fixing element is not suitable for use in the tensile zone, in which cracks occur. A further reason why it is unsuitable for the tensile zone and why it has relatively low holding values, even in uncracked concrete, is attributable in the known fixing element to the bounding of the longitudinal slot towards the leading end of the fixing element by a stop face. As a consequence, on the one hand only a slight ascending angle for the base of the longitudinal slot can be achieved and on the other hand the length of the expander element must also be considerably shortened relative to the length of the longitudinal slot in order to obtain a satisfactory displacement travel for the anchoring. If in addition further widening of the drilled hole occurs as a result of cracks forming, there is a risk that the expander element will bear against the leading stop face of the longitudinal groove and not offer any further expansion potential. This situation can also occur, for example, when the hole to be pre-drilled for the fixing element turns out to be somewhat larger than expected as the hole is being prepared.

Finally, the planar base of the longitudinal slot and planar bearing surface of the expander element provide a high contact pressure during the expansion process which can lead to cold welding. As a result, subsequent expansion and consequently suitability for use in the tensile zone are also impaired.

DE 33 34 754 C2 discloses an expansible plug, the plug body of which is of sleeve-shaped construction having an internal thread for a screw or threaded rod. The wedge-shaped expander element of this expansible plug is a part of the plug body and is joined to the plug body by way of a web remaining between incisions and acting as a desired rupture point. The incisions are arranged so that on the one hand an inclined face sloping up towards the leading end of the plug body, and on the other hand the wedge shape of the expander element, are formed. In order to provide a surface for the application of an expansion tool, a stop member projecting into the sleeve bore of the plug body is integrally formed on the expander element.

To anchor the expansible plug, the expander element is first torn off at the desired rupture point using an expansion tool and then displaced towards the leading end of the plug body. The tearing off alone of the desired rupture point demands a pushing force that requires the known expansible plug to be braced at the bottom of the drilled hole. Moreover, to bridge the incisions separating the two sliding surfaces of the plug body and the expander element, a relatively large axial displacement of the expander element is required, in order to achieve an expansion effect. Since, furthermore, both the expander element and the plug body consist of the same material, there is a risk that during the expansion the two sliding surfaces will be

damaged by cold welding and binding such that no subsequent expansion occurs. The known expansible plug is therefore unsuitable for use in the tensile zone in which drilled holes may widen as a result of cracks forming, requiring compensation through subsequent expansion.

The invention is therefore based on the problem of improving a fixing element of the kind mentioned in the introduction in such a manner that the fixing element can be driven in with little resistance, and can be anchored in a simple manner in a building component, and which has high holding values as a result of advantageous subsequent expansion behaviour even when the drilled hole widens as a result of cracks forming.

That problem is solved by the features specified in claim 1. The longitudinal slot having a trapezoidal cross-section and produced by stamping provides sliding surfaces arranged at an angle to one another, which at their surface have been compressed. The compression promotes the sliding behaviour and thus reduces the tendency to cold welding and binding as the expander element is displaced in the longitudinal slot during the expansion process. A further reduction in the tendency to bind is achieved by the decrease in contact pressure by virtue of the fact that the two sliding surfaces are arranged at an angle to one another, which at the same time also take over lateral guidance of the expander element during displacement thereof.

By virtue of the teeth of roof-shaped construction which are arranged at the external surface of the expander element and project beyond the shank with part of their height, merely a groove is scored out in the prepared drilled hole as the fixing element is driven

in. Since only the vertex of the toothed expander element digs into the wall of the drilled hole, the resistance that has to be overcome as the fixing element is driven in is low.

After driving in, the teeth arranged on the expander element hold it immovably in the drilled hole, whereas the shank is axially displaced with respect to the expander element during the anchoring process. The upwardly sloping longitudinal slot causes the expander element to be pressed radially outwards into the wall of the drilled hole, the roof-shape of the teeth reducing the resistance of the external surface of the expander element to penetrating into the wall of the drilled hole. Only a low screwing-in torque is accordingly required for the anchoring. Since, moreover, the upwardly sloping base of the longitudinal slot runs out at a distance from the leading end at the outer circumference of the shank, firstly, a longer expander element having a larger pressure-applying area can be used and, secondly, because of the steeper ascending angle of the base a greater radial expansion can be achieved with smaller axial displacements.

It has proved especially advantageous, both for the sliding behaviour and for the production of the longitudinal slot, for the two sliding surfaces to be arranged at an angle of 100° - 120° to one another, and for the width of the basal area of the two sliding surfaces to be less than the width of the basal area of the two bearing surfaces of the expander element. The latter measure ensures that the expander element lies with its bearing surfaces exclusively on the sliding surfaces.

A construction has proved advantageous in which the longitudinal slot, at its end facing towards the rear end of the fixing element, has at least a depth corresponding to half the diameter of the shank, and the ascending angle of the base lies between 11° and 13° .

So that the expander element is supported as the fixing element is being driven in, a stop member of semicircular construction is provided at the limit of the longitudinal slot facing towards the rear end of the fixing element, against which the expander element bears at its deepest position.

Furthermore, a retaining element, for example, a rubber ring, stamped bead or similar construction, can hold the expander element displaceably in the longitudinal slot before the fixing element is driven into the drilled hole, so that the expander element does not accidentally fall out of the longitudinal slot. A good locking action of the teeth combined with a low resistance to driving in is achieved by virtue of the fact that the teeth have disparate tooth flanks, the shorter tooth flank being arranged towards the leading end.

In order to facilitate driving in, in a further construction of the invention a ramp-like slope extending to the tip of the first tooth can be arranged at the leading end of the expander element.

In a further construction of the invention, the fixing element can have an internal thread at its rear end, so that by means of a screw, threaded rod or similar means an article can be fixed to the fixing element anchored in the masonry. The weight acting on the plug body

creates a slight displacement between the plug body and the fixed expander element, and by virtue of the upwardly sloping base of the longitudinal slot this displacement results in the expansion being intensified. Because of the good sliding properties of the sliding surfaces an axial displacement occurs between the expander element and the plug body even when the drilled hole widens as a result of cracks forming.

In some cases, the displacement of the plug body with respect to the expander element is undesirable, since this would also produce a displacement of the screw or threaded rod. In order to avoid such a displacement, in a further advantageous construction provision is made for a bore which extends beyond the stop shoulder into the longitudinal slot and intersects this with a part of its cross-section to adjoin the internal thread, and for the expander element to be displaceable with the screw, threaded rod or a driving-in tool towards the leading end in order to anchor the fixing element.

Between the expander element and the screw or threaded rod to be screwed in, there may furthermore be arranged a resilient element, preferably a compression spring. Such resilient biasing of the expander element causes the expander element to be pushed up subsequently when the drilled hole widens as a result of cracks forming, so that no axial displacement of the plug body is required for the subsequent expansion. A rubber bolt can also be used as the resilient element.

The invention is illustrated by embodiments shown in the drawings, in which:

- Figure 1 shows the fixing element, with an expander element lying in a longitudinal slot of its expansion zone, inserted in a hole drilled in a building component,
- Figure 2 is a partial longitudinal section of the fixing element of Figure 1 in its anchored position,
- Figure 3 is a cross-section of the fixing element according to Figure 2 along the section line A-A,
- Figure 4 is a longitudinal section of a fixing element having an internal thread shown during the anchoring process using a driving-in tool, and
- Figure 5 shows the fixing element according to Figure 4 with the threaded rod screwed in and a resilient element arranged between expander element and threaded rod.

The fixing element 1 illustrated in Figure 1 has a shank 2 having an external thread 3 at its rear end 4 and an expansion zone which is formed by a longitudinal slot 5 of trapezoidal cross-section and an expander element 6 lying in this longitudinal slot 5. The expander element 6, which is readily displaceable in the longitudinal slot 5, is held by a retaining element 7, in this particular embodiment a rubber ring.

On its external surface, the expander element 6 has teeth 8 of roof-shaped configuration in cross-section (see Figure 3). As the fixing element 1 is driven into the hole 9 drilled in the building component 10, the expander element 6 is located in its deepest position, in which the rear semicircular end face 11 of the expander element 6 bears against the limit of the longitudinal slot 5, which is likewise semicircular and

which serves as stop member 12. In that position, the teeth 8 project with part of their height beyond the shank 2 of the fixing element.

The fixing element 1 is driven right through the article 16 to be fixed, into the drilled hole. By screwing the nut 17 onto the projecting threaded portion 3 the shank 2 is displaced axially with respect to the expander element 6 towards the mouth of the drilled hole, so that the expander element 6 is pressed radially outwards by the upwardly sloping base 18 of the longitudinal slot 5 (see Figure 2). As this happens, the teeth 8 of the expander element 6 dig into the wall of the drilled hole and effect anchoring of the fixing element. The teeth 8 have a saw-toothed profile, the tooth flank 19 sloping towards the leading end 14 to reduce the resistance to driving in. Furthermore, the expander element 6 has a ramp-like slope 28, which extends from the leading end of the expander element to the tip of the first tooth.

Figure 3 shows a cross-section along the section line A-A drawn in Figure 2. The roof-shaped construction of the tooth 8 favours deep penetration of the expander element 6 into the wall of the hole drilled in the building component 10. The trapezoidal cross-section of the longitudinal slot 5 is also recognizable in Figure 3. The trapezoidal shape creates two sliding surfaces 22, 23 arranged at an angle to one another, on which the expander element 6 rests with its two bearing surfaces 24, 25. The angle β formed by the two sliding surfaces or bearing surfaces is preferably $100^\circ - 120^\circ$. In order to ensure that the bearing surfaces 24, 25 slide on the sliding surfaces 22, 23, the width of the basal area 26 between the two sliding surfaces is somewhat smaller than the width of the basal area 27

between the two bearing surfaces 24, 25 of the expander element 6.

The fixing element 1a illustrated in Figure 4 has at its rear end an internal thread 30 for receiving a screw or threaded rod. Adjoining the internal thread 30 there is a bore 31 of reduced diameter compared with the core diameter of the internal thread, which bore extends beyond the stop shoulder 12 into the longitudinal slot 5 and intersects this with a part of its cross-section. The expander element 6 therefore projects with its rear end into the bore 31 so that the ram 32 of the driving-in tool 33 bears against the rear end of the expander element 6. Using the driving-in tool 33, the expander element 6 can now be displaced on the upwardly sloping base 18 of the longitudinal slot 5 towards the bottom of the drilled hole. The expander element 6 thus becomes wedged in the hole 9 drilled in the building component 10 and effects anchoring of the fixing element. The axial displacement of the expander element 6 can also be effected directly with the screw or threaded rod to be screwed into the internal thread 30. In that case, either the internal thread 30 can be extended beyond the stop shoulder 12, or a reduced portion corresponding to the bore 31 can be arranged at the end face of the screw or threaded rod.

In the illustration of Figure 5, a threaded rod 34, for example, for suspending pipes, ceilings or similar structures, is screwed into the internal thread 30 of the fixing element 1b. A compression spring 35 is arranged as resilient element between the expander element 6 and the threaded rod 34. The compression spring 34 can either be pushed in after anchoring of the fixing element 1b by means of a driving-in tool and be clamped with the threaded rod 34, or can be used

directly for axial displacement of the expander element 6 by means of the threaded rod 34. The compression spring exerts a steady pressure on the expander element 6 after a screw or the threaded rod has been screwed in so that on the one hand the expander element 6 is pushed up subsequently when the drilled hole widens as a result of cracks forming and on the other hand at the same time a safeguard against vibration of the threaded rod 34 is provided.

The expander element 6 can be manufactured either from malleable cast iron by pressure die casting, or by cold forming in a stamping and bending die. An expander element of malleable cast iron has very good sliding properties on account of the graphite content in the malleable cast iron.

Patent Claims

1. A fixing element having retaining means arranged at its rear end for clamping an article to a building component, and having at least one expansion zone starting from the leading end and extending in the longitudinal direction for a part of the length of the shank of the fixing element, which expansion zone is formed by a longitudinal slot having a base sloping upwards towards the leading end with an expander element inserted in the longitudinal slot and displaceable therein, characterized in that the longitudinal slot (5) is formed by stamping and has a trapezoidal cross-section having two sliding surfaces (22, 23) arranged at an angle to one another and rising radially towards the leading end (14), and the expander element (6) has two bearing surfaces (24, 25) resting on the sliding surfaces (22, 23) and is provided on its external surface with teeth (8) of roof-shaped construction which project at least with a part of their height beyond the shank (2).

2. A fixing element according to claim 1, characterized in that the two sliding surfaces (22, 23) of the longitudinal slot (5) are arranged at an angle of 100° - 120° to one another.

3. A fixing element according to claim 1, characterized in that the width of the basal area (26) between the two sliding surfaces (22, 23) is less than



the width of the basal area (27) between the two bearing surfaces (24, 25) of the expander element (6).

4. A fixing element according to claim 1, characterized in that the longitudinal slot (5) has at its end facing towards the rear end (4) of the fixing element (1) at least a depth corresponding to half the diameter of the shank (2), and the ascending angle (α) of the base (18) lies between 11° and 13° .

5. A fixing element according to claim 1, characterized in that at the limit of the longitudinal slot (5) facing towards the rear end (4) of the fixing element the expander element (6) bears against a semicircular stop shoulder (12).

6. A fixing element according to claim 1, characterized in that a retaining element (7) in the form of a rubber ring acts on the expander element (6), which retaining element holds the expander element (6) displaceably in the longitudinal slot (5).

7. A fixing element according to claim 1, characterized in that the teeth (8) have disparate tooth flanks, the shorter tooth flank (19) being arranged facing towards the leading end (14).

8. A fixing element according to claim 1, characterized in that a ramp-like slope (28) extending to the tip of the first tooth (8) is arranged at the leading end of the expander element (6).

9. A fixing element according to claim 1, characterized in that an internal thread (30) for a screw, threaded rod (34) or similar means is arranged at the rear end of the fixing element (1a, 1b).



10. A fixing element according to claim 9, characterized in that a bore (31), which extends beyond the stop shoulder (12) into the longitudinal slot (5) and intersects this with a part of its cross-section, adjoins the internal thread (30), and in that the expander element (6) is displaceable with the screw, threaded rod (34) or a driving-in tool (33) towards the leading end in order to anchor the fixing element (1a, 1b).

11. A fixing element according to claim 1, characterized in that the expander element (6) is manufactured from malleable cast iron.

12. A fixing element according to claim 1, characterized in that the expander element (6) is manufactured from a sheet metal blank, the edges of the sheet metal blank being bent inwards in a roof shape and the teeth (8) being stamped in.

