

DESCRIPTION

The invention relates to a composite concrete-steel component with a steel part and a concrete part, which are interconnected by means of at least one metallic welded dowel welded onto the steel part, the dowel having a shank with a welded end.

Steel - concrete composite construction offers a broad field of use for such dowels. The dowels are welded by means of a known stud welding process to a steel component to be connected to the concrete. Such a steel component can e.g. be a composite beam for bridge or building construction, a metallic liner for steel or reinforced concrete hollow bodies or buildings or an anchor plate for anchoring loads in a concrete structure. Generally the concrete is directly connected to the steel component and optionally at the same time forms the formwork or part thereof. Such a steel - concrete composite component is known from US-A-32 10 900, which has been used as a basis for drafting the preamble of claim 1. Such a dowel has a shank with a circular cylindrical diameter, on whose one end is formed a head with an increased diameter. By means of the end opposite to the head the dowel is welded on, the dowel material being monolithically connected during the welding process to the material of the steel girder below it and an all-round weld forms at the base of the dowel.

Of considerable constructional significance for such composite concrete - steel components is the bearing or carrying behaviour of the dowel. A distinction must be made between tensile loads, i.e. loads acting in the direction of the longitudinal axis of the dowel, and shear loads, i.e. loads acting in the steel - concrete interface direction. The bearing behaviour of the dowel is very important with respect to the shearing load, which occurs e.g. as a planned loading due to shear forces between the steel and the concrete or can be introduced in the form of a load to be anchored. The shear loading can e.g. also occur as a result of thermal expansion, settlement or the like.

An important aspect of the dowel bearing behaviour in the case of shear loading is the failure type. The failure of a dowel connection of the above-indicated type can occur either in the form of a steel failure (the dowel shears or tears off) or in the form of a concrete failure (as a fracture of a usually funnel-shaped concrete part). It is more favourable for the bearing behaviour of the connection or joint, if a concrete failure can be avoided, as is also the case with most of the presently constructed composite steel - concrete constructions, in that adequately long dowels are used. The bearing behaviour with respect to shearing loads is

essentially determined by two parameters, namely the breaking load, i.e. the maximum shear force, which can be absorbed by the dowel connection, and the fracture movement, i.e. the maximum movement between the steel component and the concrete. The bearing behaviour is well illustrated by plotting the shear force over the movement as a so-called load deformation line. The surface area below this line is called the kinetic energy of the dowel, which should be high.

DE 89 06 810 U1 discloses a multipart upsetting tie bolt, whose lower end can be fitted to a tie rail by means of an upsetting joint. The upsetting tie bolt comprises a dowel-like upper shank part, which has a substantially circular cylindrical cross-section and is provided at the upper end with a head. The lower end of the dowel-like shank part is welded to a base part. The base part also has a shank-like construction and can be inserted in a recess of the tie rail. After inserting the base part in the tie rail, said base part is upset or compressed to such an extent that it cannot be removed from the rail again and is consequently joined therewith.

The problem of the invention is to give a composite concrete - steel component of the aforementioned type a better bearing behaviour in the case of shearing loads.

The problem is solved in that a dowel is welded, in which, prior to the welding to the welded end, the shank has a portion with a larger diameter than the remaining shank portion.

The invention takes account of the fact that in the case of conventional dowels when high loads occur, wide areas of the dowel shank participate in the removal of the shearing loads in the concrete, the load removal largely taking place by means of pressures or stresses between the dowel shank and the concrete. As a result of the increased diameter portion according to the invention in the vicinity of the welded end, the pressures are concentrated in the vicinity of this portion. Therefore the displacement of the concrete linked with the dowel movement is reinforced, which causes higher dowel movements and also a greater activation of further load removal mechanisms, such as e.g. axial tensile forces in deformed bolts. Tests have revealed that dowels with the increased diameter portion not only have a much more favourable bearing behaviour than conventional dowels with a constant diameter over the entire length and which corresponds to the diameter of the remaining shank portion of the dowel according to the invention, but also that if the diameter of the conventional dowel corresponds to the diameter of the increased diameter portion according to the invention, the bearing behaviour of the constant diameter dowel is inferior to that of dowels having an increased diameter portion. Therefore it is merely a question of the description method and is unimportant for the inventive concept whether the design of the dowel is obtained by reducing the cross-section of the remaining shank portion or by an increase in the vicinity of

the welded end. What is important is the clear increase in the fracture movement and the resulting rise in the kinetic energy. Importance is also attached to the fact that with respect to the breaking load a significant improvement is obtained, if the idea of a dowel increased in diameter at the welded end is used, whereas only small losses occur with respect to the breaking load, if the dowel is considered as a dowel with a reduced diameter of the remaining shank portion.

A particularly simple construction from the manufacturing standpoint is obtained if the remaining shank portion and the increased diameter portion are constructed rotationally symmetrically to a common axis and such a dowel also has a symmetrical bearing behaviour.

It can also be advantageous for certain load combinations to give a prismatic construction to the remaining shank portion and/or the increased diameter portion.

In a simple, preferred development the remaining shank and/or the increased diameter portion in each case are shaped like a straight circular cylinder.

However, for further optimizing the bearing behaviour, the increased diameter portion can be spherical in the axial direction.

If the increased diameter portion passes with a constant taper into the remaining shank portion, there is a more uniform overall stressing of the dowel particularly in the vicinity of the transition from the larger diameter portion to the remaining shank portion with a normal cross-section and it is possible to avoid an effect action, which is undesired in connection with dynamic stresses.

To ensure an adequate anchoring in the concrete, in the conventional manner the dowel can have a head at its free end. According to an embodiment, in this case the head diameter is at least as large as the diameter of the increased diameter portion.

According to a preferred development, the ratio of the length to the diameter of the increased diameter portion is between 1:2 and 4:2, preferably between 1:2 and 3:2. Thus, the dowel can be welded by means of known stud welding processes and this also ensures a particularly favourable deformation behaviour.

According to another preferred development, the ratio of the length to the diameter of the remaining shank portion without the head is approximately 3:1 or greater, which ensures an adequate anchoring of the dowel in the concrete and a tearing of the dowel out of the concrete as a result of shear loading is avoided.

In order to optimize the kinetic energy of a dowel, it is also provided that the ratio of the diameter of the increased diameter portion to that of the remaining shank portion is between 7:6 and 10:6 and is preferably about 9:6 and/or that the ratio of the length of the increased diameter portion to that of the remaining shank portion without the head is at least 1:3 and the upper limit can be 1:8. Preferably this ratio is between 1:4 and 1:7.

For further improving the deformation behaviour, the increased diameter portion can have a stepped cross-sectional increase.

The invention is described in greater detail hereinafter relative to an embodiment and the attached drawings, wherein show:

- Fig. 1 A view of a welded dowel.
- Fig. 2 A section II - II according to Fig. 1.
- Fig. 3 A dowel with an outside spherical portion.
- Fig. 4 A dowel with an inside spherical portion.
- Fig. 5 A dowel with two stepped portions.
- Fig. 6 A dowel in a modified construction.
- Fig. 7 A graph with load - deformation lines.

Fig. 1 shows a welded dowel, whose shank has at the welded end 3 an increased diameter portion 2. The increased diameter portion 2 and the remaining shank portion 1 are in each case shaped like a straight circular cylinder. The increased diameter portion 2 in the represented embodiment passes in uniform manner via a transition portion 4 into the remaining shank portion 1. The dowel is welded by means of a stud welding apparatus to a not shown steel component by the free end of the increased diameter portion 2/welded end 3. At the end opposite to the welded end 3, in the represented embodiment, the dowel has a head 5, which is used for transferring loads directed parallel to the dowel longitudinal axis between the concrete and the dowel and therefore serves to improve the anchoring of the dowel in the concrete.

Fig. 2 is a section II - II of the dowel according to Fig. 1. It is possible to see the circular cross-section of the increased diameter portion 2, the head 5 and the remaining shank portion 1 shown in broken line form. In this embodiment the diameter of the increased diameter portion 2 is increased by approximately 40% compared with that of the remaining shank portion 1. In order to achieve a good anchoring of the dowel in the concrete, the diameter of the head 5 is much larger than the increased diameter portion 2. As the increased diameter portion 2, the remaining shank portion 1 and the head 5 are located in rotationally symmetrical manner on an axis, the dowel can be easily manufactured.

In the installation state the complete dowel is inserted in the concrete. In the case of shearing loads, i.e. a load at right angles to the longitudinal axis of the dowel in the vicinity of the welded end 3, high pressures or stresses occur between the dowel and the concrete. In the case of small shearing loads the pressures or stresses are concentrated in the vicinity of the welded end 3. With increasing shearing loads the size of the area of the dowel used for load removal purposes increases. In the case of dowels having a constant diameter over the entire length, as a function of the concrete composition, this area can extend to almost the entire dowel length. This more particularly applies to large diameter dowels having a high bending resistance. If the diameter of the conventional dowel is decreased to approximately $2/3$ of the original diameter over a length of approximately 80% from the head 5, then the dowel according to Fig. 1 is obtained. In the case of high shearing loads with this dowel the pressures are concentrated in the vicinity of the increased diameter portion 2. Compared with a conventional dowel having a diameter corresponding to that of the increased diameter portion 2, the shearing loads which have to be transferred are consequently somewhat lower. However, they are well above the shearing loads, which a conventional dowel with a diameter corresponding to that of the remaining shank portion 1 is able to transfer. Due to the concentration of the pressures in the vicinity of the increased diameter portion 2, unlike in the case of conventional dowels, the concrete there is stressed to a much greater extent. This leads to greater deformations of the concrete and to an increase in the locally defined areas of concrete displacement. This in turn permits greater dowel movements, i.e. greater movements of the dowel base, which in this case corresponds to the increased diameter portion 2 and this occurs at right angles to the dowel longitudinal axis. With increasing movements there is also an increase in the axial tensile forces in the dowel. With their proportion running parallel to the shearing load, they make a significant contribution to the breaking load of the dowel. They also cause deformations of the remaining shank portion 1, which also leads to an increase in the movements of the increased diameter portion 2. This explains why a very significant gain in the fracture movement merely leads to a small loss in the breaking load of the dowel or even to a clear gain in the breaking load, as a function of which of the aforementioned consideration methods is chosen. This will become clear hereinafter relative to the graph of Fig. 7.

Figs. 3, 4 and 5 show different embodiments of the increased diameter portion 2. These constructions, in conjunction with different concrete types, offer an improved bearing behaviour in the case of shearing loads.

In the graph according to Fig. 7 are plotted the load - deformation lines of three dowels. Two of these lines, namely A and B, show the load - deformation behaviour of conventional dowels. Both dowels have the same length and a constant cross-section over the entire

length. The length corresponds to the total length of the dowel according to Fig. 1. The diameter corresponds to the diameter of the remaining shank portion 1 according to Fig. 1 for curve A and the diameter of the increased diameter portion 2 according to Fig. 1 for curve B. The shear force F is plotted in kN over the shear movement s in mm, s representing the relative movement of the steel component and therefore also the dowel base relative to the concrete part. It can be seen that for curve A and the associated dowel, the breaking load is approximately 80 kN and the fracture movement approximately 7.5 mm, whereas for curve B and the associated dowel the breaking load is approximately 155 kN and the fracture movement approximately 9.0 mm. Curve C resulted from a test on the dowel according to Fig. 1, whose shank diameter over approximately 80% of the dowel length corresponded to the dowel according to curve A and whose diameter in the increased diameter portion corresponded to that of the dowel according to curve B. It can be seen that the breaking load at approximately 140 kN is somewhat lower than in the case of curve B, but with approximately 29 mm there is a significant increase in the fracture movement. Thus, under the constructional conditions used in this example the kinetic energy of the dowel is increased by a factor of 5.5 or 3.0 by having an increased diameter portion as opposed to the dowels associated with curves A and B. These values can be influenced by modifying the constructional circumstances.

Naturally the bearing behaviour and bearing capacity of a dowel according to the invention in the case of tensile loading largely correspond to those of a conventional dowel having a constant diameter corresponding to that of the remaining shank portion 1. However, frequently the shearing loads are decisive for dowel design, so that such an increased fracture movement, the clearly increased kinetic energy and the high breaking loads in the shear direction are much more decisive. Particular significance is attached to the large fracture movements, e.g. when using the load factor design in composite construction. Another advantage of the reduced diameter of the dowel according to Fig. 1 with respect to the remaining shank portion is that more space is available for placing reinforcing rods in the concrete. This is e.g. important when using anchor plates, in the vicinity of which increased reinforcement is often necessary.



CLAIMS

1. Composite concrete-steel component with a steel part and a concrete part, which are interconnected by means of at least one metallic welded dowel welded onto the steel part, the dowel having a shank with a welded end (3), characterized in that a dowel is welded, in which, prior to welding to the welded end (3), the shank has a portion (2) with a larger diameter than the remaining shank portion (1).
2. Composite component according to claim 1, characterized in that the remaining shank portion (1) and the larger diameter portion (2) are rotationally symmetrical to a common axis.
3. Composite component according to claim 1, characterized in that the remaining shank portion (1) and the larger diameter portion (2) are shaped like a prism.
4. Composite component according to claim 1, characterized in that the remaining shank portion (1) is rotationally symmetrical and the larger diameter portion (2) prismatic, or the remaining shank portion (1) is prismatic and the larger diameter portion (2) is rotationally symmetrical.
5. Composite component according to claim 1, 2 or 4, characterized in that the remaining shank portion (1) and/or the larger diameter portion (2) are in each case shaped like a straight circular cylinder.
6. Composite component according to one of the preceding claims, characterized in that the larger diameter portion (2) is axially dome-shaped.
7. Composite component according to one of the preceding claims, characterized in that the larger diameter portion (2) passes



- with a continuous taper (4) into the remaining shank portion (1).
8. Composite component according to one of the claims 1 to 7, characterized in that at its free end the dowel has a head (5).
 9. Composite component according to one of the preceding claims, characterized in that the diameter of the head (5) is at least as large as the diameter of the larger diameter portion (2).
 10. Composite component according to one of the preceding claims, characterized in that the length to diameter ratio of the larger diameter portion (2) is between 1:2 and 4:2.
 11. Composite component according to claim 10, characterized in that the length to diameter ratio of the larger diameter portion (2) is between 1:2 and 3:2.
 12. Composite component according to one of the preceding claims, characterized in that the length to diameter ratio of the remaining portion (1) without the head (5) is approximately 3:1 or larger.
 13. Composite component according to one of the preceding claims, characterized in that the diameter of the larger diameter portion (2) to that of the remaining shank portion (1) is between approximately 7:6 and 10:6.
 14. Composite component according to claim 13, characterized in that the ratio of the diameter of the larger diameter portion (2) to that of the remaining shank portion (1) is approximately 9:6.



15. Composite component according to one of the preceding claims, characterized in that the ratio of the length of the larger diameter portion (2) to that of the remaining shank portion (1), without the head (5), is at least 1:3.
16. Composite component according to claim 15, characterized in that the ratio of the length of the larger diameter portion (2) to that of the remaining shank portion (1), without the head (5) is between 1:3 and 1:8.
17. Composite component according to claim 16, characterized in that the ratio of the length of the larger diameter portion (2) to that of the remaining shank portion (1), without the head (5), is between 1:4 and 1:7.
18. Composite component according to one of the preceding claims, characterized in that the larger diameter portion (2) has a stepped cross-sectional enlargement.