

PATENT SPECIFICATION

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(72) Inventors JAN FRANCISCUS DEN TIETER

ALPHONSUS IGNATIUS MARIA CLAESSEN



(54) PILE

(71) We, SHELL INTERNATIONALE RESEARCH MAATSCHAPPIJ B.V., a company organised under the laws of The Netherlands, of 30 Carel van Bylandtlaan, The Hague, The Netherlands, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed to be particularly described in and by the following statement:—

The invention relates to a pile or a similar vertical foundation element.

In most cases the points of foundation elements rest on a bearing layer, for example a layer of sand the load being absorbed by toe resistance. Sometimes the load is absorbed by toe resistance, combined with frictional resistance to movement of the pile which is developed in directly superposed, consolidated soil layers (so-called positive friction). If the said consolidated soil layers have layers on their top which are not sufficiently consolidated and which may be compressed under the influence of extraneous superimposed loads or otherwise, downward frictional forces can occur along the pile (so called negative friction). The occurrence of negative friction considerably reduces the net bearing capacity of the pile.

It has already been proposed to increase the net bearing capacity of a pile or a similar vertical foundation element by reducing or eliminating the negative friction acting on the pile, and U.K. Specification No. 900,665 discloses a pile or a similar vertical foundation element which has the sides thereof coated with a bituminous slide layer in order to reduce or eliminate negative friction acting on the pile.

According to the present invention a pile or a similar vertical foundation element provided with means for reducing or eliminating negative friction acting on the pile has the sides of the upper part of the pile coated

completely or substantially completely with a bituminous slide layer, the sides of the lower part of the pile are not coated with a bituminous side layer, and directly contiguous to and underneath the bituminous slide layer a protective portion of increased cross-sectional area or a protective rim or collar is provided.

In one embodiment of pile in accordance with the invention the protective portion consists of the whole of the lower part of the pile.

In another embodiment of pile in accordance with the invention the protective rim or collar is formed by a ring provided on the pile.

These embodiments of the pile or similar vertical foundation element have the advantage that the bituminous slide layer is effectively prevented from tearing or stripping off during driving operations because the bituminous slide layer on the upper part of the pile is protected by said protective portion or said protective rim or collar. Since the bituminous slide layer is only applied to that part of the pile where negative friction may occur and not to that part of the pile where positive friction may occur, the tendency of the negative friction to decrease the bearing capacity is reduced or eliminated; whereas the tendency of the positive friction to increase the bearing capacity is retained.

The invention will now be described with reference to the accompanying drawings in which:

Fig. 1 shows a side-view of a first embodiment of the pile according to the invention;

Fig. 2 shows a cross-section taken on the plane II-II of the pile according to Fig. 1;

Fig. 3 shows a cross-section taken on the plane III-III of the pile according to Fig. 1;

Fig. 4 shows a cross-section taken on the plane IV-IV of the pile according to Fig. 1;

Fig. 5 shows a side-view of a second embodiment of the pile according to the

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invention.

Referring to figure 1 the pile consists essentially of a lower part 2, an upper part 3, a handling part 4 and finally a bearing point 5 at the lower end.

As shown in Fig. 2, the lower part 2 has a cross-section which is essentially square. The sides 6 of the lower part 2 are not provided with a bituminous slide layer.

As shown in Fig. 3, the upper part 3 has a cross-section which is likewise essentially square. The cross-section of the upper part 2 is smaller than that of the lower part 2. The sides 7 are coated with a bituminous slide layer 8.

As shown in Fig. 4, the handling part 4 has a cross-section which is likewise square. This cross-section square is equal in size to the cross-section formed by the sides 7.

It will be appreciated that the sides 9 of the handling part 4 are not coated with a slide layer.

As will be clear from Fig. 1, the section of the lower part 2 changes at 10 to the smaller section of the upper part 3. The difference in distance between a pair of parallel sides 6 of the lower part and a pair of parallel sides 7 of the upper part can be, for example, 2.5 cm. In this example the thickness of the bituminous slide layer 8 can be for example 1 cm.

During use the non-coated handling part 4 serves for the picking up of the pile by means of a crane and for an accurate positioning of the pile cap. After the driving operation, the pile is usually topped *in situ* to connect the reinforcement of the pile with a superposed foundation. Before being driven in, the pile is already provided with the bituminous slide layer 8. The pile may, for example, have been previously factory-made, and, if desired, it may also have been provided with a slide layer at the factory. It will be appreciated that the slide layer can alternatively be applied *in situ* before the driving operation.

The pile is driven into the ground in the usual manner until the bearing point 5 has reached the desired depth. Since the lower part 2 has a larger cross-section than the upper part 3, the slide layer 8 is protected during the driving operation by the part 2, thus preventing the bituminous slide layer 8 from being torn or stripped off during the driving operation. Once the pile has reached the desired depth, the non-coated lower part 2 is located in consolidated layers which exert a positive friction on the pile, thus adding to the net bearing capacity of the pile. The upper part 3, which is provided with the bituminous slide layer 8, is located in non-consolidated layers which might exert a negative friction on the pile but for the fact that the effect of this negative friction is eliminated or drastically reduced

by the bituminous slide layer 8.

The pile according to the invention can be made of reinforced concrete, which may or may not be pre-stressed. It will be appreciated that the invention can also be applied, if desired, to wooden or steel piles.

In the embodiment hereinbefore described the pile is essentially square in cross-section. Instead the cross-section of the pile may be circular, or it may have the shape of a regular polygon (for example an octagon). In the case of a pile of circular cross-section, the diameter of the section across the lower part 2 will be larger than the diameter of the section across the upper part 3.

The total length of the lower part 2, together with the length of the bearing point 5 preferably exceeds 10 times the distance between the parallel sides 6 of the square formed by the cross-section of the lower part 2. If the cross-section of the lower part 2 is circular, the said length preferably exceeds 10 times the diameter of this circular cross-section.

As shown in Fig. 5, the second embodiment of the pile according to the invention is a plain pile, which has the same cross-section over its entire length. The bearing point is represented by reference numeral 15 and the handling part by reference numeral 14. The upper part 13 of the pile is coated with a bituminous slide layer 18. The lower part 12 of the pile is not coated with bituminous material. A protective rim or collar is provided which is formed by a ring 22 on the pile, which ring is pushed over the pile to make direct contact with the bituminous slide layer 18. The ring 22 is tightly secured to the pile. In the case of a concrete pile, use may for example, be made of a steel ring 22, which is tightly secured to the reinforcement of the concrete. In the case of a steel pile, use may be made of a steel ring 22 which is welded to the pile.

Alternatively, the ring 22 may be clamped to the pile; this may be useful, for example, if a wooden pile is employed. It is also possible to provide the ring 22 with a clasp or cage engaging the lower end of the pile to prevent the ring 22 from being pushed upwards.

A suitable bitumen is, for example, of the type described in British Patent Specification 900,665, namely a bitumen with a penetration between 20 and 100 and a 120 penetration index of between -1 and +2.

WHAT WE CLAIM IS:—

1. A pile or a similar vertical foundation element, provided with means for reducing or eliminating negative friction acting on the pile, wherein the sides of the upper part of the pile are coated completely or substantially completely with a bituminous slide layer, the sides of the lower part of the pile are not coated with a bituminous slide

invention.

Referring to figure 1 the pile consists essentially of a lower part 2, an upper part 3, a handling part 4 and finally a bearing point 5 at the lower end.

As shown in Fig. 2, the lower part 2 has a cross-section which is essentially square. The sides 6 of the lower part 2 are not provided with a bituminous slide layer.

As shown in Fig. 3, the upper part 3 has a cross-section which is likewise essentially square. The cross-section of the upper part 2 is smaller than that of the lower part 2. The sides 7 are coated with a bituminous slide layer 8.

As shown in Fig. 4, the handling part 4 has a cross-section which is likewise square. This cross-section square is equal in size to the cross-section formed by the sides 7.

It will be appreciated that the sides 9 of the handling part 4 are not coated with a slide layer.

As will be clear from Fig. 1, the section of the lower part 2 changes at 10 to the smaller section of the upper part 3. The difference in distance between a pair of parallel sides 6 of the lower part and a pair of parallel sides 7 of the upper part can be, for example, 2.5 cm. In this example the thickness of the bituminous slide layer 8 can be for example 1 cm.

During use the non-coated handling part 4 serves for the picking up of the pile by means of a crane and for an accurate positioning of the pile cap. After the driving operation, the pile is usually topped *in situ* to connect the reinforcement of the pile with a superposed foundation. Before being driven in, the pile is already provided with the bituminous slide layer 8. The pile may, for example, have been previously factory-made, and, if desired, it may also have been provided with a slide layer at the factory. It will be appreciated that the slide layer can alternatively be applied *in situ* before the driving operation.

The pile is driven into the ground in the usual manner until the bearing point 5 has reached the desired depth. Since the lower part 2 has a larger cross-section than the upper part 3, the slide layer 8 is protected during the driving operation by the part 2, thus preventing the bituminous slide layer 8 from being torn or stripped off during the driving operation. Once the pile has reached the desired depth, the non-coated lower part 2 is located in consolidated layers which exert a positive friction on the pile, thus adding to the net bearing capacity of the pile. The upper part 3, which is provided with the bituminous slide layer 8, is located in non-consolidated layers which might exert a negative friction on the pile but for the fact that the effect of this negative friction is eliminated or drastically reduced

by the bituminous slide layer 8.

The pile according to the invention can be made of reinforced concrete, which may or may not be pre-stressed. It will be appreciated that the invention can also be applied, if desired, to wooden or steel piles.

In the embodiment hereinbefore described the pile is essentially square in cross-section. Instead the cross-section of the pile may be circular, or it may have the shape of a regular polygon (for example an octagon). In the case of a pile of circular cross-section, the diameter of the section across the lower part 2 will be larger than the diameter of the section across the upper part 3.

The total length of the lower part 2, together with the length of the bearing point 5 preferably exceeds 10 times the distance between the parallel sides 6 of the square formed by the cross-section of the lower part 2. If the cross-section of the lower part 2 is circular, the said length preferably exceeds 10 times the diameter of this circular cross-section.

As shown in Fig. 5, the second embodiment of the pile according to the invention is a plain pile, which has the same cross-section over its entire length. The bearing point is represented by reference numeral 15 and the handling part by reference numeral 14. The upper part 13 of the pile is coated with a bituminous slide layer 18. The lower part 12 of the pile is not coated with bituminous material. A protective rim or collar is provided which is formed by a ring 22 on the pile, which ring is pushed over the pile to make direct contact with the bituminous slide layer 18. The ring 22 is tightly secured to the pile. In the case of a concrete pile, use may for example, be made of a steel ring 22, which is tightly secured to the reinforcement of the concrete. In the case of a steel pile, use may be made of a steel ring 22 which is welded to the pile.

Alternatively, the ring 22 may be clamped to the pile; this may be useful, for example, if a wooden pile is employed. It is also possible to provide the ring 22 with a clasp or cage engaging the lower end of the pile to prevent the ring 22 from being pushed upwards.

A suitable bitumen is, for example, of the type described in British Patent Specification 900,665, namely a bitumen with a penetration between 20 and 100 and a penetration index of between -1 and +2.

WHAT WE CLAIM IS:—

1. A pile or a similar vertical foundation element, provided with means for reducing or eliminating negative friction acting on the pile, wherein the sides of the upper part of the pile are coated completely or substantially completely with a bituminous slide layer, the sides of the lower part of the pile are not coated with a bituminous slide



layer, and directly contiguous to and underneath the bituminous slide layer a protective portion of increased cross-sectional area or a protective rim or collar is provided.

2. A pile as claimed in claim 1, wherein the protective portion consists of the whole of the lower part of the pile.

3. A pile as claimed in claim 1, wherein the protective rim or collar is formed by a ring provided on the pile.

4. A pile as claimed in any one of claims 1-3, wherein the pile is made of reinforced concrete.

5. A pile as claimed in claim 4, wherein the pile is made of pre-stressed concrete.

6. A pile as claimed in any one of claims 1-3 wherein the pile is made of steel.

7. A pile as claimed in any one of claims 1-3, wherein the pile is made of wood.

8. A pile or a similar vertical foundation element provided with means for reducing or eliminating negative friction acting on the pile, substantially as described with reference to Figures 1-4 or figure 5 of the accompanying drawings.

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R. C. ROGERS
Chartered Patent Agent
Shell Centre,
London, S.E.1.

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