PATENT SPECIFICATION

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COMPLETE SPECIFICATION

Improvements in Ramming Devices and Methods of Use in Constructing Concrete Piles and the like

We, THE BRITISH STEEL PILING COMPANY LIMITED, a British Company, and ALFRED HILEY, a British Subject, both of Thames House, Millbank, London, S.W.1, do hereby declare the nature of this invention, and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement:—

This invention relates to ramming devices for use in constructing concrete piles and the like of the kind adapted to be inserted into a preparatory tube, the ramming device having a wedge-like gripping member adapted to engage the inner wall of the preparatory tube and to be forced outwardly against the inner wall by upward pressure applied to the ramming device. When the gripping member is in the engaged position the ramming device can be driven downwardly by driving the preparatory tube so that anything below the ramming device is also driven downwardly.

In devices of this kind hitherto employed the problem has been to design the gripping members so that a positive grip is obtained between the ramming device and the tube without the parts becoming so locked together that they cannot easily be released. It must be remembered that in use the device may be operated at a considerable depth and is therefore not readily accessible so that if difficulty were experienced in releasing the device a great deal of time and labour may be wasted.

The invention also relates to improvements in the method of using such devices for constructing concrete piles and the like.

The object of the present invention is to provide an improved ramming device which will overcome the above difficulties. A ramming device according to the present invention is characterised by the provision of one or more auxiliary wedges disposed between said wedge-like gripping member and the body of the ramming device, the arrangement being such that when engaging relative movement takes place principally between the wedge-like gripping member and the adjacent auxiliary wedge and when releasing the initial relative movement takes place principally between the body of the ramming device and the adjacent auxiliary wedge.

It is of course understood that the body of the ramming device must be able to move relative to the tube so that it is necessary to have a reaction member on the other side of the ramming device which permits this movement and which may take the form of another wedge-like gripping member or some other form of reaction member may be employed.

Referring to the drawings filed herewith:—

Fig. 1 is a sectional elevation of one form of ramming device made in accordance with the present invention the ramming device being shown suspended within the preparatory tube.

Fig. 2 is a sectional elevation of the same ramming device in the ramming position.

Figs. 3, 4 and 5 are sectional views on the lines 3—3, 4—4, and 5—5 of Fig. 2 respectively.

Fig. 6 is a sectional elevation of a modified form of ramming device.

Fig. 7 is a section on the line 7—7 of Fig. 6.

Figs. 8 to 16 are diagrammatic views in elevation showing various stages of the processes of forming concrete piles with the use of the ramming device according to the present invention.

Fig. 17 is a sectional elevation of the foot of the preparatory tube showing a shoe which may be used if desired.

In the form shown in Figs. 1 to 5 the ramming device has a body portion 1 formed with a sloping face 2 against which is positioned an auxiliary wedge 3, a wedge-like gripping member 4 being positioned between the auxiliary wedge 3 and the inner face of a preparatory tube 5 within which the ramming device is positioned. On the other side of the body 1 is provided a reaction member consisting of a toggle 6 having a rounded end which is positioned in a recess 7 and is held in position by a retaining pin 8 loosely mounted in the body 1. The

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outer extremity of the reaction member 6 is provided with teeth 9 to engage the inner wall of the preparatory tube 5.

The toggle 6 is provided with a forked lug 10 between the wings of which is positioned a link 11 having shoulders 12 and 13 the lower end of the link being secured between the forked lug 10 by a pin 14. The upper end is guided within the head of the body 1 and is slotted to receive the suspension rope 15 the other end of which is connected to the wedge-like gripping member 4 the upward movement of which is limited by contact with the head of the body 1.

The shoulder 12 on the link 11 forms a stop to limit the upward movement of the auxiliary wedge 3. The shoulder 13 on the link 11 buts against the top of the body 1, a suitable removable distance piece 16 being provided the thickness of which is selected to obtain the desired limit of upward movement of the link 11. The auxiliary wedge 3 is positioned by means of a stirrup 17 mounted on top of the auxiliary wedge 3 which stirrup 17 embraces a pin 18 secured in the body 1. The auxiliary wedge 3 is further formed with a projecting portion 19 adapted to engage the shoulder 20 formed at the upper extremity of the sloping face 2. Upward movement of the auxiliary wedge 3 relative to the pin 18 is resisted by a resilient packing 21 positioned within the stirrup 17 between the top of the auxiliary wedge and the pin 18 whilst downward movement is normally prevented by contact between the projecting portion 19 and shoulder 20. Mounted on top of the stirrup 17 is a buffer 22 which engages the shoulder 13 of the link 11 whilst driving takes place.

The downward movement of the toggle 6 is restricted by a buffer stop 23 which engages the under-side of the toggle 6 to prevent it moving past dead centre. The body 1 is extended downwardly to a suitable depth to keep the operating parts clear of material on which the device bears, to steady the device within the tube and keep it in alignment, a projecting rib 24 being formed on the body 1 near the base and below the wedge-like gripping member 3. The base of the body 1 is provided with a centrally and axially formed threaded hole adapted to receive a plug 25 which may be removed and replaced by a cylindrical cutter for taking samples of ground.

In the form shown in Figs. 6 and 7 the same reference letters have been used where possible. This modified form is designed for dealing with larger forces than the construction above described. Instead of the toggle 6 and link 11 a reaction member 30 is provided which is made to engage the tube 5 on a suitably larger area than the toggle 6. The teeth 9 extend over a greater length than is the case with the toggle 6 and the reaction surface being opposite the wedge-like gripping member 4 maintains the alignment and avoids the necessity of the projecting rib 24 bearing against the tube 5 for this purpose. The reaction member 30 is slotted at 31, a pin 32 secured in the body 1 passing through the slot 31 to retain and guide the upper part of the reaction member 30, the lower part being retained in position by the pin 8. Upward movement of the reaction member 30 is limited by the top of the foot-like extension 33 which also engages the buffer 23 to limit the downward movement. The construction of the buffer 23 is different being intended to take greater loads. The buffer 23 is cylindrical and is disposed in a central bore formed in the body 1 which bore is enlarged to form an air chamber 34 and is threaded to receive the removable plug 25 and a second plug 35 formed with a key hole 36 by which its position in the bore can be adjusted. Between the plug 35 and the buffer 23 are disposed a series of resilient rubber washers 37 and separators 38, the expansion of the washers 37 in a radial direction being limited by the walls of the bore or by flanges on the separators 38 so that the buffer yields readily until further expansion of the washers 37 cannot take place whereafter the resistance to further movement increases suddenly.

In operation the ramming device is lowered down the tube 5 the weight being carried on the rope 15 so that the wedge-like gripping member 4 is fully withdrawn. The toggle 6 will also be in the raised position whilst in the modified form the reaction member 30 will rest on the buffer 23. As soon as the bottom of the ramming device contacts with anything in the tube 5 such as concrete, the wedge-like gripping member 4 will slide down until the teeth engage the inner surface of the tube 5. In the form shown in Figs. 1 to 5 the toggle 6 will also turn slightly until it rests on the buffer stop 7. In the form shown in Figs. 6 and 7 no movement of the reaction member 30 takes place relative to the body 1. If the tube is now driven downwards an upward pressure will be exerted against the plug 25. Since the projecting portion 19 of the auxiliary wedge 3 is already pressed lightly in contact with the shoulder 20 on the body 1, no relative movement takes place between the auxiliary wedge 3 and the body 1 but the auxiliary wedge 3 pressed

upwardly by the body 1 slides up the wedge-like gripping member 4 pressing this firmly against the tube 5 and exerting a corresponding pressure against the toggle 6 or the reaction member 30 on the opposite side of the tube 5. The buffer stop 23 yields sufficiently to allow the body 1 to move upwards along with the auxiliary wedge. In order to reduce friction the sliding surface on both sides of the auxiliary wedge are greased before use. In the form shown in Figs. 6 and 7 the sliding surface between the reaction member 30 and the body 1 is also greased before use. When the upward pressure on the plug 25 is removed as for example by giving an upward blow to the tube 5 the inward pressure of the tube 5 on the wedge-like gripping member 4 and reaction member 30 or toggle 6 tends to move the body 1 downwardly. Since the widest angle is between the auxiliary wedge 3 and the body 1, this is primarily where movement commences as the ramming device is released. If the device is working correctly the release takes place automatically and unless a tension is applied to the rope 15 the device will slide bodily down the tube until the plug 25 again rests on whatever is in the tube 5, all the parts automatically assuming the position shown in Figs. 2 and 6 respectively. In the form shown in Figs. 6 and 7 the chamber 34 forms an expansion chamber for air trapped beneath the buffer 23 and prevents a high degree of vacuum being formed beneath the buffer 23 which would cause moisture and grit to be drawn past the buffer 23 as the latter rose up on the release taking place. The resilient packing 21 assists the auxiliary wedge 3 to keep its correct position i.e., with the projecting portion 19 in contact with the shoulder 20 and when the maximum upward force is being exerted the buffer stop 22 comes into contact with the shoulder 12 and helps to transmit more of the load to the reaction member.

It will be seen that if the tube 5 is reciprocated as for instance by a hammer which gives blows in an upward and downward direction the ramming device will be caused to move with a ratchet like action down the tube 5 forcing before it concrete introduced in the tube 5 or anything else such as a pilot pile positioned therein.

The various processes which can be carried out with the ramming device according to the invention will now be briefly described with reference to Figs. 8—17. In depositing and ramming moist concrete the preparatory tube 5 is first sunk into the ground. This may be done by placing the open-ended tube on a pile of stones with the ramming device inside the tube (see Fig. 8) and then driving the tube into the ground by means of a steam hammer 40 fitted on the top of the tube. The steam hammer 40 is adapted to impart vertical blows in either direction. The ramming device will remain locked in the tube and the latter carrying the stones with it will pierce the ground as though its end were sealed. When the desired depth has been reached, in which position it is shown in Fig. 9, the ramming device is released as already described and extracted from the tube by means of the rope 15 and a charge of moist concrete introduced into the tube. The ramming device is then inserted once more into the tube on top of the concrete therein as illustrated in Figs. 2 or 6 and diagrammatically in Fig. 10.

Assuming that it is now desired to form an enlargement at the base of the pile being constructed, either of the following methods can be adopted according to the character of the ground in which the operation is being carried out. According to the first method the tube 5 is raised by the hammer until the ramming device has nearly reached the end of the tube. During this operation the ramming device remains resting on top of the concrete and the tube slides upwards past it under each successive blow of the hammer. The next step consists in driving the tube downwardly with the hammer. Immediately the first blow is applied to the tube the ramming device will grip the side of the tube and remain firmly locked thereto until the upward pressure beneath has been released. Repeated downward blows of the hammer on the tube will force the ramming device into the mass of moist concrete beneath causing it to be pressed outwardly into the surrounding strata. This operation may be repeated until the desired size of footing has been obtained.

The second method of forming the footing which is more suitable for use in spongy or plastic strata consists in oscillating the tube by means of the hammer 40. With each upward movement of the tube the ramming device will release and fall back onto the top of the concrete and with each downward movement the ramming device will grip the tube and move down with the tube, the effect being to cause the ramming device to move down the tube with a ratchet like movement. This method compacts the concrete and if a less fluid mix is used than would normally be the case the tendency for the pressure of the ground to press back the concrete is overcome and a good footing

obtained. During this reciprocating movement of the tube 5 the upward movement can be made greater than the downward movement so that the tube 5 is gradually withdrawn until the desired length of enlargement has been obtained. When the footing has been formed the rest of the pile can be constructed in the usual way or the device can be reinserted at any stage for the purpose of compositing the concrete as it is deposited or forming additional enlargements.

Sometimes it is desired to drive a pilot pile through and below the footing formed in the manner above described. Figs. 14 and 15 show diagrammatically the process of driving a pilot pile. After the footing has been formed the precast concrete pile 41 is inserted into the tube 5 on top of the deposited concrete. The ramming device is then lowered into the tube until it rests on top of the pilot pile 41. The tube 5 is then reciprocated or given a series of downward blows followed by a series of upward blows repeated until the pilot pile has been caused to be driven out of the tube by the action of the ramming device. The pilot pile will then become bonded with the enlargement through which it has been driven and the construction of the rest of the pile can be completed in the ordinary way. Fig. 14 shows the pilot pile 41 during the driving process and Fig. 15 shows the finished pile. The pilot pile 41 forms an extension of the pile reaching a depth within firm strata beyond the scope of the piling tube 5 employed.

If a concrete pile is to be constructed in water-logged ground such as in a river bed, the bottom of the tube 5 is closed by a light cast iron shoe 42 in the initial drive (corresponding to Fig. 9) to ensure that no water enters the tube prior to its being charged with concrete. When during the process of depositing concrete from the tube, the latter gradually moves upwardly, the shoe is left in the ground. This is shown in Fig. 16, from which it can also be seen that in these cases it is usual to form an enlargement at a low depth where the ground is firm enough to ensure the safety of the pile construction. This enlargement is highly rammed and, after further depositing concrete up to the river bed, a strong precast reinforced concrete pile is introduced while the deposited concrete is still moist thereby displacing it laterally. To furnish an adequate factor of safety the enlargement is made large enough to provide a bearing area such as for example 4 times the normal area of the pile section.

The form of pile illustrated in Fig. 16 is particularly suitable for use in districts where earthquake shocks are experienced. The large bulge would provide good support and within limits, a ball-an-socket action can take place between the bulge and the surrounding strata.

Instead of the pointed shoe 42 as shown in Fig. 16, an improved light shoe 51 may be used in the manner illustrated in Fig. 17. The shoe 51 is completely filled with hardened concrete before use. The shoe is then fitted to the bottom of the tube 5. The ramming device is then inserted into the tube with the body 1 bearing on the concrete in the shoe 51. This enables a comparatively thin shoe to be used and should the shoe, during driving, hit violently upon some hard object, there is no danger of its breaking to pieces or of broken pieces, grit or water penetrating into the interior of the tube.

Having now particularly described and ascertained the nature of our said invention and in what manner the same is to be performed, we declare that what we claim is:—

1. A ramming device of the kind adapted to be inserted into a preparatory tube, the ramming device having a wedge-like gripping member adapted to engage the inner wall of the preparatory tube and to be forced outwardly against the inner wall by upward pressure applied to the ramming device characterised by the provision of one or more auxiliary wedges disposed between said wedge-like gripping member and the body of the ramming device, the arrangement being such that, when engaging, relative movement takes place principally between the wedge-like gripping member and the adjacent auxiliary wedge and, when releasing, the initial relative movement takes place principally between the body of the ramming device and the adjacent auxiliary wedge.

2. A ramming device as claimed in claim 1 wherein a reaction member is provided to engage with the tube on the side of the ramming device remote to the wedge-like gripping member, said reaction member comprising a toggle mounted in the ramming device.

3. A ramming device as claimed in claim 1 wherein a reaction member is provided to engage with the tube on the side of the ramming device remote to the wedge-like gripping member, said reaction member comprising a member slidably mounted on the body of the ramming device so as to be capable of a limited axial movement with respect thereto.

obtained. During this reciprocating movement of the tube 5 the upward movement can be made greater than the downward movement so that the tube 5 is gradually withdrawn until the desired length of enlargement has been obtained. When the footing has been formed the rest of the pile can be constructed in the usual way or the device can be reinserted at any stage for the purpose of compositing the concrete as it is deposited or forming additional enlargements.

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2. A ramming device as claimed in claim 1 wherein a reaction member is provided to engage with the tube on the side of the ramming device remote to the wedge-like gripping member, said reaction member comprising a toggle mounted in the ramming device.

3. A ramming device as claimed in claim 1 wherein a reaction member is provided to engage with the tube on the side of the ramming device remote to the wedge-like gripping member, said reaction member comprising a member slidably mounted on the body of the ramming device so as to be capable of a limited axial movement with respect thereto.

4. A ramming device according to claim 2 or 3 wherein the reaction member is provided with teeth to assist in gripping the tube.

5. A ramming device according to claim 1 wherein two or more wedge-like gripping members are provided arranged around the body of the ramming device whereby each serves as the reaction member for the remainder.

6. The process of ramming concrete and causing it to be deposited and/or driving a precast concrete pile from a preparatory tube, which consists in inserting in said tube on top of said concrete a ramming device made according to any of the preceding claims and constructed for unidirectional movement therein and reciprocating said tube whereby said ramming device is caused to move downward in said tube with a ratchet like action.

7. A process of driving a preparatory tube with a shoe on the foot thereof which consists in employing a ramming device according to any of the preceding claims 1 to 5, said ramming device resting on said shoe during driving substantially as and for the purpose described with reference to Fig. 17.

8. The constructional form of apparatus shown in Figs. 1, 2, 3, 4 and 5 of the drawings and described with reference thereto.

9. The constructional form of apparatus shown in Figs. 6 and 7 and described with reference thereto.

10. The process of constructing a concrete pile described with reference to Figs. 8 to 13.

11. The process of constructing a concrete pile or like column including the driving of a pilot pile described with reference to Figs. 14 to 15.

12. The process of constructing a concrete pile or like column described with reference to Fig. 16.

13. The process of constructing a concrete pile or like column substantially as described with reference to the accompanying drawings.

14. A pile, or like column, constructed according to any of the processes claimed herein.

Dated this 14th day of December, 1936.

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