

The invention relates to a method for making an excavation by the diaphragm wall technique using platform elements with releasable prestressing.

The diaphragm wall technique has become the reference method for making excavations running below the level of the ground water when the surrounding conditions do not make it possible to effect a lowering of the water level.

Briefly the making of an excavation by this technique consists of surrounding the future excavation with a diaphragm wall constructed in a conventional manner and then proceeding with the excavation and positioning, as the excavation progresses, anchoring ties for the purpose of retaining the wall against the thrust exerted on it by the ground and the ground water on the other side of the diaphragm wall.

However, situations are fairly often encountered in which the installation of anchoring ties is not possible or is too onerous, for example when the surrounding ground lacks sufficient cohesion for it to be possible to anchor a tie in it firmly. In such case, the positioning of platforms at various levels in the excavation is then substituted for the installation of anchoring ties. This solution, as described for example in FR-A-1 450 745 is nevertheless not always very satisfactory since it has been noted that, particularly in the case of excavations with a relatively large area, the diaphragm wall is subjected to high bending moments which may for example reach 150-200 tonnes-metre, which means that it is necessary to use diaphragm walls of great thickness, whence a high cost. In spite of that, it has been observed that the diaphragm wall could undergo severe local deformations which may, for example, attain 4-5 centimetres, which cannot be tolerated.

The aim of the present invention is to provide an improved method for making an excavation by the diaphragm wall technique, which makes it possible to minimise the deformations and bending moments to which the diaphragm wall is subjected, and consequently to reduce the thickness of the diaphragm wall and therefore the cost.

More particularly, the present invention relates to a method for making an excavation by the diaphragm wall technique, according to which a diaphragm wall surrounding the excavation to be made is constructed, and then the excavation is made, positioning platforms at various levels in the excavation, fulfilling the role of supports for the said wall, as is known from the aforesaid patent FR-A-1450745, characterised in that platforms consisting of prestressed platform elements are put in place between at least two opposite walls and in that after the said positioning all or part of the prestressing applied to the said elements is released so that the said elements expand and exert on the diaphragm wall a counter-thrust opposite to the thrust exerted on the said wall by the ground and/or the surrounding ground water.

The method of the invention derives an advantage from the fact that the prestressed platform elements, when all or part of their prestressing is released, undergo an extension or expansion which generates on the diaphragm wall a thrust opposed to the one exerted on the other side of the wall by the ground and/or the surrounding water.

The counter-thrust exerted by the platform elements does not need to balance the thrust of the ground and/or surrounding water and will normally be less than this.

The positioning of the prestressed platform elements will depend on the magnitude of the thrusts exerted by the surrounding ground

on the diaphragm wall and, therefore, on the dimensions of the excavation and the nature of the said ground.

In some cases, it will be possible to position the prestressed elements so that the directions of their prestressing are parallel to each other over the various levels of platform put in place. In other cases, it will be appropriate to put in place, at some levels, prestressed elements in which the direction of prestressing is at right angles to that in the platform elements at other levels. In all cases which may be encountered in practice, the professional will easily be able to determine the optimum orientation and positioning of the prestressed platforms necessary for obtaining the desired result, the method of the invention lending itself easily to computer modelling.

According to one particular embodiment, the prestressed concrete platform elements used in the method of the invention comprise members for prestressing under tension whose ends are embedded in the concrete and whose middle part is covered by a sheath with the application of a lubricating agent between the said middle part and the said sheath, apertures being provided in the concrete to allow the cutting of the said middle part and thus the release of the prestressing tension.

It should be noted that, in addition to the prestressing members (for example steel strands), each platform element may contain within it metal reinforcements designed to strengthen it.

The following description made with respect to the accompanying drawings will give a clear understanding of the invention.

Figures 1 and 2 are diagrammatic views in plan and cross section respectively of a prestressed platform element used in the invention;

Figure 3 is an enlarged view of the circled part of Figure 2; and

Figures 4 and 5 are diagrammatic views in plan and cross section along the line V-V of Figure 4, respectively, of an excavation made according to the method of the invention.

Figures 1, 2 and 3 show a platform element made from prestressed concrete used in the invention. This element 1 has in plan view an overall rectangular shape and, in cross section, the shape of a T. A plurality of prestressing metal strands 2, running parallel to the longitudinal direction of the element over the entire length of the latter, are embedded in the element and distributed both in the arms of the T and in the leg of the T. Each strand comprises a middle part 3 covered with a sheath 4 with the interposition of a lubricant (grease for example) between the strand and the sheath, and bared end parts 5 (with no sheath or lubricant). Apertures 6 provided on the bottom part of the element give access locally to each of the strands, over its middle part, as shown in Figure 2 and, enlarged, in Figure 3. Finally, the element 1 includes metal strengthening reinforcement 7. For guidance, each element may have a length of 15 metres, a total width of 2.5 metres (formed by two arms each with a length of 1 metre and a thickness of 0.2 metres and a middle part (the leg of the T) with a width of 0.5 metres and a thickness of 0.6 metres). The strands (16 in number in the embodiment shown) may be embedded in the concrete at a distance of approximately 5 cm from the bottom surface of the arms or the lateral surfaces of the leg of the T, each strand being prestressed to 10 tonnes (ie a total prestressing of 160 tonnes per platform element). The bared end parts of each strand can have, for example, a length of 0.8 metres.

Such an element can easily be manufactured by placing, in a mould with a suitable shape, strands whose end pass through and beyond the end faces of the mould, applying the desired prestressing to them by means of conventional equipment, pouring the concrete

into the mould, and then, after hardening of the concrete, removing the prestressing equipment and cutting off the protruding ends of the strands. The bared ends, which are then immobilised in the concrete of the element, maintain the prestressing initially applied over the lubricated and sheathed middle part.

After the positioning of the prestressed platform elements, as described in more detail below, the prestressing applied to a given strand can be released easily by locally "burning" the said strand by means, for example, of the flame from a cutting torch, using the aperture 6 giving access to this hole. The middle part of each metal strand does not in fact adhere to the concrete of the element because of the presence of the lubricated sheath which surrounds it. It is possible to release the prestressing from all the strands or from only some of these, as desired, depending on the magnitude of the counter-thrust which it is desired to apply to the diaphragm wall.

In Figures 4 and 5, the construction of an excavation in accordance with the invention has been illustrated. This excavation, 80 metres long, 60 metres wide and 23.75 metres deep, has been made in ground consisting of clay (from 0 to 5 metres down), sand (from 5 to 12 metres down), gravel (from 12 to 25.5 metres down) and then marl, water (ground water) being present from the 1 metre level down to the layer of marl.

After the construction, in a conventional manner, of a diaphragm wall 10 in the ground surrounding the future excavation, having a thickness of 0.8 metres and extending to a depth of approximately 28 metres (in the marl), a plurality of posts 11 are put in place, arranged in rows at intervals of 15 metres across the width of the excavation and 10 metres along the length of the excavation, and then the excavation is made, putting in place, as the excavation progresses, platforms produced using prestressed elements according to the invention, at depths of 3.7, 8.75,

11.65, 14.55, 17.55 and 20.35 metres respectively.

Since the width (60 m) of the excavation exceeds by far the length of the prestressed elements which can be produced in practice (having regard to the constraints of manufacture and transport), four elements 15 m long are disposed end to end in order to cover this width. As, in order to cover the length (80 m) of the excavation, 32 elements (2.5 m wide) placed side by side are required, it would be necessary, in theory, to use 128 elements for each level of platform. In practice, however, it will be advisable to provide passages for passing from one level to another and therefore to omit a few elements on each level to allow such passage, as shown at 12. The elements on a given level rest at their ends on reinforced concrete beams 13 previously put in place either on the diaphragm wall or between two adjacent posts in two rows parallel to the width of the excavation, or between a post and the diaphragm wall, depending on circumstances. Once the elements have been put in place, the small spaces between the consecutive elements or between the elements and the diaphragm wall are filled in using concrete so as to form joints 14. After hardening of the joints, the prestressing is released from the elements by "burning" the prestressing strands by means of a cutting torch, as explained above.

It has been found in the embodiment of the excavation described above that it was possible, with a concrete diaphragm wall 0.8 m thick, to limit the maximum movements of the wall, consequent upon the thrust of the ground and the surrounding water, to approximately 2 cm, the maximum moments to which this wall was subjected being approximately 100 tonnes-metre.

If the excavation were made in a conventional manner, with decking elements which were not prestressed, the diaphragm wall would be subjected to much higher stresses, namely one of maximum moments of the order of 160 tonnes-metre, which would cause

maximum movements of approximately 4 cm, which is unacceptable in practice and would result in the need to construct a thicker diaphragm wall, of the order of 1 metre, in order to reduce the said movements.

The method of the invention therefore makes it possible to achieve an economy of the order of 20% with respect to the quantity of materials necessary for the construction of the diaphragm wall, which is equivalent to a saving in costs which is also of the order of 20%.

It goes without saying that the embodiment described is only one example and that it would be possible to modify it, notably by the substitution of equivalent techniques, without for all that departing from the scope of the invention as defined by the accompanying claims.

CLAIMS

1. A method of making an excavation by the diaphragm wall technique, according to which a diaphragm wall (10) is constructed in the ground surrounding the excavation to be made, and then the excavation is made whilst putting platforms in place at various levels in the excavation, fulfilling the role of supports for the said wall, characterised in that, between at least two opposite walls, platforms (1) consisting of prestressed platform elements are put in place and in that, after the said putting in place, all or part of the prestressing applied to the said elements is released so that the said elements expand and exert on the diaphragm wall a counter-thrust opposite to the thrust exerted on the said wall by the ground and/or the surrounding ground water.

2. A method according to claim 1, characterised in that the directions of prestressing of all the platform elements are parallel to each other.

3. A method according to claim 1, characterised in that the direction of prestressing of the platform elements put in place at some levels is at right angles to the direction of prestressing of the platform elements put in place at other levels.

4. A method according to claim 1, characterised in that the platform elements comprise tension prestressing members (2), whose ends (5) are embedded in the concrete and whose middle part (3) is covered with a sheath (4) with the application of a lubricating agent between the said middle part and the said sheath, apertures (6) being provided in the concrete to allow the cutting of the said middle part and, thus, the release of the prestressing tension.

