METHOD OF SINKING AND LINING A SHAFT

Abstract: A method of sinking and lining a shaft (10). The method includes the steps of excavating a shaft (10) in the ground and lowering a first shaft liner (12) into the shaft (10), then progressively extending the shaft (10) downwardly. The shaft (10) is extended by excavating earth from beneath the lowest existing shaft liner (12) and providing a further shaft liner (28) dimensioned to pass through the existing shaft liners (12). The further shaft liner (28) is passed downwardly through the existing shaft liners (12) until an upper end of the further shaft liner (28) is adjacent a lower end of the lowest shaft liner (12). A portion of the further shaft liner (28) adjacent an upper end is then expanded and secured to the lower end of the lowest shaft liner (12).
For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

Published:
— with international search report
TITLE

“METHOD OF SINKING AND LINING A SHAFT”

FIELD OF THE INVENTION

The present invention relates to a method of sinking and lining a shaft.

SUMMARY OF THE INVENTION

In accordance with one aspect of the present invention there is provided a method of sinking and lining a shaft comprising the steps of excavating a shaft in the ground and lowering a first shaft liner into the shaft, then progressively extending the shaft downwardly by one or more repetitions of the following steps:

excavating earth from beneath the lowermost existing shaft liner;

providing a further shaft liner, the further shaft liner being dimensioned to pass through the existing shaft liners;

passing the further shaft liner downwardly through the existing shaft liners until an upper end of the further shaft liner is adjacent a lower end of the lowermost shaft liner;

expanding only a portion of the further shaft liner adjacent an upper end thereof; and securing the upper end of the further shaft liner to the lower end of the lowermost shaft liner.

BRIEF DESCRIPTION OF THE DRAWINGS

The present invention will now be described, by way of example, with reference to the accompanying drawings, in which:
Figure 1 is a side view of a first shaft liner installed in accordance with an initial step of the method of the present invention;

Figure 2 is a side view of excavation of earth beneath the first shaft liner;

Figure 3 is a side view of a second shaft liner being lowered into the shaft;

Figure 4 is a side view of the second shaft liner being suspended inside the first shaft liner;

Figure 5 is a side view of a plug being installed over the opening of the shaft;

Figure 6 is a side view of a headframe being used to lower the second shaft liner downwardly through the first shaft liner;

Figure 7 is a side view of the first and second shaft liners being secured together;

Figure 8 is a side view of excavation of earth under the second shaft liner in preparation for installation of a third shaft liner; and

Figure 9 is a side view of an alternative method of connecting the first and second shaft liners.

**DESCRIPTION OF THE INVENTION**

Referring to the Figures, there is shown a method of sinking and lining a shaft 10. Generally, the method includes the using telescoping shaft liners to line a shaft which is sunk in successive stages. Each further shaft liner is inserted through the existing shaft liners installed in the shaft to a position below the lowermost existing shaft liner.

Referring to Figure 1, there is shown an initial step in sinking and lining the shaft 10 in accordance with the present invention. Initially, the earth is excavated by known means to a depth equal to the length of a first shaft liner 12, plus the depth of a plug 14 to be used to seal across the shaft 10. In the embodiment shown, the first shaft liner 12 comprises a cylindrical steel liner.
The first shaft liner 12 is lowered into the shaft 10 and levelled. The first shaft liner 12 is then secured in position by a lower concrete layer 16 provided around the first shaft liner 12 adjacent a lower end of the first shaft liner 12. Preferably the lower concrete layer 16 covers around one quarter of the depth of the first shaft liner 12. The volume around the first shaft liner 12 above the lower concrete layer 16 is then filled with sand 18 up to a point below an upper end of the first shaft liner 12. An upper concrete layer 20 is then provided around the upper end of the first shaft liner 12. The upper concrete layer 20 is provided with a recess 22 arranged to receive the plug 14 such that an upper surface of the plug 14 is level with the surface of the ground.

Referring to Figure 2, the plug 14 is then inserted into the recess 22 so that a headframe 24 may be moved onto the plug 14, over the shaft 10. The plug 14 is provided with one or more suitable apertures to provide access to the shaft 10. The tyres of the headframe 24 are then deflated and a sucker supported on the headframe 24 is lowered into the shaft 10 and used to excavate earth from beneath the first shaft liner 12. The first shaft liner 12 remains in place due to the first and second concrete layers 16 and 20.

Once sufficient earth has been removed from beneath the first shaft liner 12 to receive a second shaft liner 28, the headframe 24 is removed by inflating the tyres and moving the headframe 24 off the plug 14. The plug 14 is then removed. The second shaft liner 28 is constructed to have an outside diameter slightly less than the inside diameter of the first shaft liner 12. Preferably, the outside diameter of the second shaft liner 28 is around 20mm less than the inside diameter of the first shaft liner 12. The second shaft liner 28 is then lowered inside the first shaft liner 12 by a crane 30 until an upper end of the second shaft liner 28 is adjacent an upper end of the first shaft
liner 12. The second shaft liner 28 is suspended by slings provided attached to respective lugs on the upper end of the first shaft liner 12, as shown in Figure 4.

As shown in Figures 5 and 6, the plug 14 is reinserted into the recess 22 and the headframe 24 driven back over the shaft 10. A gear winch provided on the headframe 24 is then used to pick up the slings connected to the second shaft liner 28 and raise the second shaft liner 28 sufficiently disconnect the second shaft liner 28 from the lugs on the first shaft liner 12. The headframe 24 then lowers the second shaft liner 28 downwardly until the upper end of the second shaft liner 28 is adjacent the lower end of the first shaft liner 12. While it may be possible to lower the second shaft liner 28 directly to the bottom of the excavated shaft 10 with the crane 30, the method described above and shown in Figure 4 using the headframe 24 would be advantageous due to the additional capabilities available on the headframe 24. Further, the use of the crane 30 may not be allowable below certain depths.

As shown in Figure 7, the second shaft liner 28 is levelled so that the upper end thereof is level with the lower end of the first shaft liner 12. The upper end of the second shaft liner 28 is provided with a plurality of longitudinal slots 32 such that the upper end may be expanded outward using a jack or other suitable device. The upper end of the second shaft liner 28 is expanded outwardly until the diameter matches that of the first shaft liner 12. The upper end of the second shaft liner 28 is then secured to the lower end of the first shaft liner 12 by welding. Further, the longitudinal slots 32 are welded to provided a water tight seal.

Figure 9 shows an alternative method of securing the upper end of the second shaft liner 28 to the lower end of the first shaft liner 12. In this embodiment, a connecting member 33 is provided. The connecting member 33 comprises a tapered portion of
shaft liner. The connecting member 33 is tapered from a diameter equivalent to that of the first shaft liner 12 at a first end to a diameter equivalent to that of the second shaft liner 28 at a second end. The connecting member 33 is provided in one or more segments to be lowered down the shaft where they are welded together to form the completed connecting member 33 and welded at the first end thereof to the first shaft liner 12 and at the second end thereof to the second shaft liner 28.

The second shaft liner 28 is also provided with a plurality of holes through which concrete can be poured to provide a lower concrete layer 34. Preferably the lower concrete layer 34 of the second shaft liner 28 extends approximately one quarter of the way up from the lower end of the second shaft liner 28. The void 36 above the lower concrete layer 34 remains empty unless poor ground conditions dictate that it be filled with concrete.

The earth below the second shaft liner 28 is then excavated and further shaft liners may be installed using the same method as described above for installation of the second shaft liner 28.

It will be appreciated that while, in the embodiment described with reference to the drawings, the area under the existing shaft liner is excavated sufficiently to lower the next shaft liner to a point completely below the existing shaft liner, this could be performed in stages. That is, once the further shaft liner is supported by the headframe 24 as shown in Figure 6, the headframe may be used to excavate a portion of the earth under the existing shaft liner and then lower the further shaft liner down to the bottom of the excavated shaft 10 and then repeat the process until the desired depth is reached.
Modifications and variations as would be apparent to a skilled addressee are deemed to be within the scope of the present invention.
CLAIMS

1. A method of sinking and lining a shaft characterised by comprising the steps of excavating a shaft in the ground and lowering a first shaft liner into the shaft, then progressively extending the shaft downwardly by one or more repetitions of the following steps:

   excavating earth from beneath the lowermost existing shaft liner;

   providing a further shaft liner, the further shaft liner being dimensioned to pass through the existing shaft liners;

   passing the further shaft liner downwardly through the existing shaft liners until an upper end of the further shaft liner is adjacent a lower end of the lowermost shaft liner;

   expanding only a portion of the further shaft liner adjacent an upper end thereof; and

   securing the expanded upper end of the further shaft liner to the lower end of the lowermost shaft liner.

2. A method of sinking and lining a shaft in accordance with claim 1, characterised in that the portion of the further shaft liner adjacent the upper end is provided with a plurality of longitudinal slots extending from the upper end and the upper end portion is expanded by application of force from within the further shaft liner.

3. A method of sinking and lining a shaft in accordance with claim 2, characterised in that a jack is used to provide the force to expand the upper portion of the further shaft liner.
4. A method of sinking and lining a shaft in accordance with claim 1, characterised in that the expansion of the further shaft liner is by means of a connecting member, the connecting member being a portion of shaft liner of diameter tapering from a diameter equal to that of the first shaft liner at a first end thereof to a diameter equal to that of the further shaft liner at a second end thereof, wherein the connecting member is secured at the first end thereof to the lower end of the first shaft liner and secured at the second end thereof to the upper end of the further shaft liner.

5. A method of sinking and lining a shaft in accordance with claim 4, characterised by providing the connecting member in a plurality of segments, lowering the segments down the shaft, welding the segments together to form the connecting member and welding the first end of the connecting member to the lower end of the first shaft liner and the second end of the connecting member to upper end of the further shaft liner.

6. A method of sinking and lining a shaft in accordance with any one of claims 1 to 5, characterised in that the first shaft liner is secured by the steps of: pouring concrete around the lower end of the first shaft liner to create a lower concrete layer; filling space around the first shaft liner above the first concrete layer with sand up to a point adjacent the upper end of the first shaft liner; and pouring concrete around the upper end of the first shaft liner with concrete to form an upper concrete layer.

7. A method of sinking and lining a shaft in accordance with claim 6; characterised in that the further shaft liners are secured by pouring concrete around the lower end of the first shaft liner to create a lower concrete layer.
8. A method of sinking and lining a shaft in accordance with claim 6 or 7, characterised in that the shaft liners are each provided with a plurality of holes through which the concrete is poured.

9. A method of sinking and lining a shaft in accordance with any one claims 6 to 8, characterised in that the upper concrete layer is provided with a recess to receive a plug having an aperture, the plug being placed over the shaft to allow excavating equipment to be moved on top of the plug and excavate the shaft through the aperture.

10. A method of sinking and lining a shaft in accordance with claim 9, characterised by the steps of:

10 lifting the further shaft liners into the first shaft liner and suspending the further shaft liner to the first shaft liner;

placing the plug over the shaft to allow excavating equipment to be moved on top of the plug;

securing the further shaft liner to the excavating equipment;

15 releasing the further shaft liner from the first shaft liner; and

lowering the further shaft liner to the bottom of the shaft.

11. A method of sinking and lining a shaft in accordance with claim 9 or 10, characterised in that the excavating equipment is a headframe.
**INTERNATIONAL SEARCH REPORT**

**Classification of Subject Matter**

Int. Cl. 7: E21D 1/08, 5/00, E21B 43/10

According to International Patent Classification (IPC) or to both national classification and IPC

**Fields Searched**

Minimum documentation searched (classification system followed by classification symbols)

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable search terms used)

Dwpi: E21D 1/08, 5/00, E21B 43/10, E02D 29/12, 17/06, 23/08, E03F 5/02 AND ((shaft+ or caiss+) AND lin+)

**Documents Considered to be Relevant**

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