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(54) Method of providing a foundation pile with enlarged base in the ground.

(57) A metal drill pipe fitted with a drill head at the lower end thereof is introduced into the ground under axial pressure while being rotated and during rotation of the drill pipe a hardening mass is supplied via an injection tube mounted within the drill pipe to an outlet opening provided at the tip of the drill head at a pressure above the hydrostatic pressure, the hardening mass mixing intensively with the soil mass stirred by the drill head. According to he invention, the hardening mass is supplied to the outlet opening (4) at such a pressure that it forms a bearing zone (9) around the foundation pile (1) of a diameter greater than the diameter of the drill head (2).

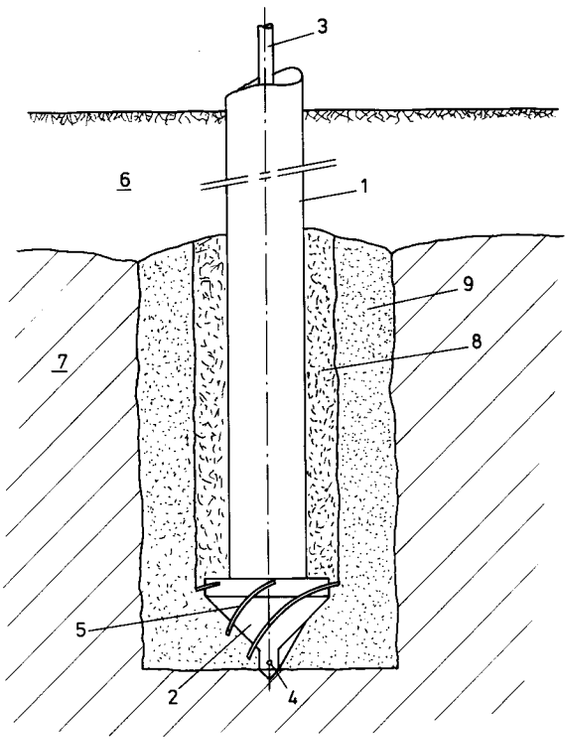

FIG.2

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This invention relates to a method of providing a foundation pile with enlarged base in the ground, in which method a metal drill pipe fitted with a drill head at the lower end thereof is introduced into the ground under axial pressure while being rotated and during rotation of the drill pipe a hardening mass is supplied via an injection tube mounted within the drill pipe to an outlet opening at the tip of the drill head at a pressure above the hydrostatic pressure, the hardening mass mixing intensively with the soil mass stirred by the drill head.

Such a method is known from German patent specification 35.01.439. In this known method, an enlarged pile base can be provided at the lower end of the metal drill pipe of the foundation pile, the width of the enlarged base being equal to the diameter of the drill head. The pressure at which the hardening mass is supplied to the outlet opening in the tip of the drill head naturally depends on the length of the foundation pile and is typically 20 – 40 bar.

The object of the invention is to provide a method which enables increasing the bearing capacity of the foundation pile. To that end, the method according to the invention is characterized in that the hardening mass is supplied to the outlet opening at such a pressure that it forms a bearing zone around the foundation pile of a diameter greater than the diameter of the drill head. Preferably, the hardening mass is supplied to the outlet opening at a pressure of at least 500 bar.

Surprisingly, it has been found that when the hardening mass is supplied at pressures of 500 bar or more, the grout mixture egressing from the outlet opening in the form of a sharp, cutting jet is intensively mixed with the soil mass adjacent the metal drill pipe owing to the shape of the drill, while beyond the intensively mixed grout – soil mass thus formed, a considerably broader, second zone is formed, with the pores present in the soil mass being filled with the hardening mass to a considerable degree, whereby a considerably higher bearing capacity of the foundation pile is obtained.

In practice, a method is known under the name of "Jet Grouting", in which a thin, hollow needle comprising one or two outlet openings at the tip thereof is driven into the ground while being rotated, with a hardening mass being supplied to the outlet openings via the interior of the needle at pressures of 500 bar and more, which mass penetrates the surrounding soil in the form of a sharp jet. When the needle has reached the desired depth, it is retracted from the ground.

In this manner, it is possible to increase the bearing capacity of the soil, but the homogeneity of the bearing column thus obtained is insufficient and consequently the extent of the increase of the bearing capacity is insufficiently reliable.

Surprisingly, it has been found that this lack of reliability of the jet – grouting system disappears when this system is combined with the method known from German patent specification 35.01.439.

The method according to the invention will hereinafter be further explained, with reference to the accompanying drawings, in which:

Fig. 1 shows a metal drill pipe with drill head, as known from DE – C – 35.01.439; and

Fig. 2 shows a foundation pile according to Fig. 1 arranged in the ground, along with the zones surrounding this pile in a bearing soil layer.

Fig. 1 shows a metal drill pipe 1 fitted at the bottom thereof with a drill head 2, which is connected to the metal drill pipe 1, for instance by welding. The drill head 2 comprises a plurality of ridges 5, which may optionally be provided with teeth to facilitate drilling and intensify the mixing of soil material with the grout flowing from the outlet opening 4. The outlet opening 4 is provided in or adjacent the tip of the drill head 2. The drill head may comprise more than one outlet opening 4. Provided within the metal drill pipe 1 is a pipe or injection tube 3 suitable for high pressures, via which the fluid to be supplied to the drill head 2 during drilling can be passed to the outlet opening 4.

In Fig. 2, a non – bearing soil layer is indicated at 6, while a bearing soil layer is indicated at 7. While the metal drill pipe 1 is being bored into the non – bearing soil layer 6, water and/or bentonite is supplied to the outlet opening 4 of the drill head 2 via the injection tube 3. The water and/or bentonite primarily function as drilling fluid. As soon as the drill head 2 has reached a bearing layer 7, a mixture of water and cement (grout) is supplied to the injection tube 3 by switching the pump connected to it. The ridges 5 provide for intensive mixing of the water/cement mixture flowing from the outlet opening with the soil material adjacent the drill head 2, as a result of which a substantially annular zone of soil material intensively mixed with grout is formed above the drill head. The diameter of this zone 8 is equal to the diameter of the drill head 2. The material in zone 8 adheres strongly to the external wall of the metal drill pipe 1 and, upon hardening of the mixture, is capable of transmitting bearing power to the surrounding soil. In the known method described above, the supply pressure for the hardening mass is typically 20 – 40 bar. The bearing capacity of a foundation pile so formed is 250 tons if the diameter of the drill pipe is about 40 cm.

By passing the grout mixture via the injection tube to the outlet opening 4 at a much higher pressure, which may for instance be 500 – 1000 bar, the grout mixture egressing in the form of a

sharp, cutting jet can penetrate zone 9 located beyond the above-described zone 8, which zone 9 is in principle not stirred by the drill head when it is being bored into the ground or at least is stirred to a considerably lesser extent than the soil material in zone 8. The grout mixture egressing from the outlet opening 4 yields a considerably enlarged pile base in zone 9, which contributes substantially to an increased bearing capacity.

In this way, using a relatively thin metal drill pipe 1 having for instance a diameter of about 40 cm and a drill head having a diameter of about 60 cm, a pile base (zone 9) of a diameter of 1.2 - 1.5 m can be obtained. The diameter of zone 8 is equal to the diameter of the screwed head 2, i.e. about 60 cm. A pile so constructed can bear a load of 500 - 750 tons, i.e. 2 - 3 times more than the known foundation pile, while extremely minimal settlement was observed. The high bearing capacity is obtained by increasing both the point bearing capacity and the friction of the enlarged pile base.

Claims

1. A method of providing a foundation pile with enlarged base in the ground, wherein a metal drill pipe fitted with a drill head at the lower end thereof is introduced into the ground under axial pressure while being rotated and during rotation of the drill pipe a hardening mass is supplied via an injection tube mounted within the drill pipe to an outlet opening at the tip of the drill head at a pressure above the hydrostatic pressure, said hardening mass mixing intensively with the soil mass stirred by the drill head, characterized in that the hardening mass is supplied to the outlet opening (4) at such a pressure that it forms a bearing zone (9) around the foundation pile (1) of a diameter greater than the diameter of the drill head (2).

2. A method according to claim 1, characterized in that the hardening mass is supplied to the outlet opening (4) at a pressure of at least 500 bar.

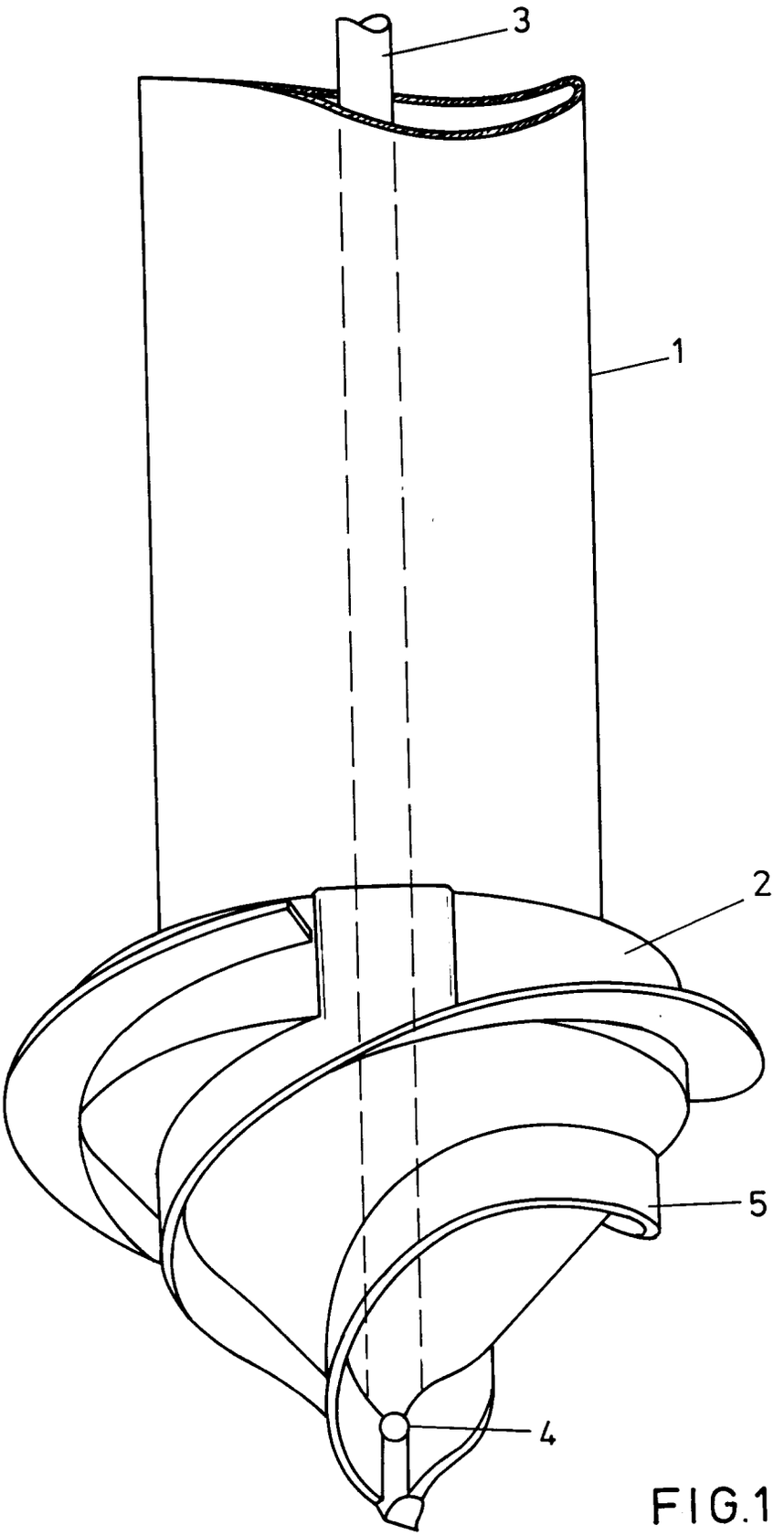

FIG.1

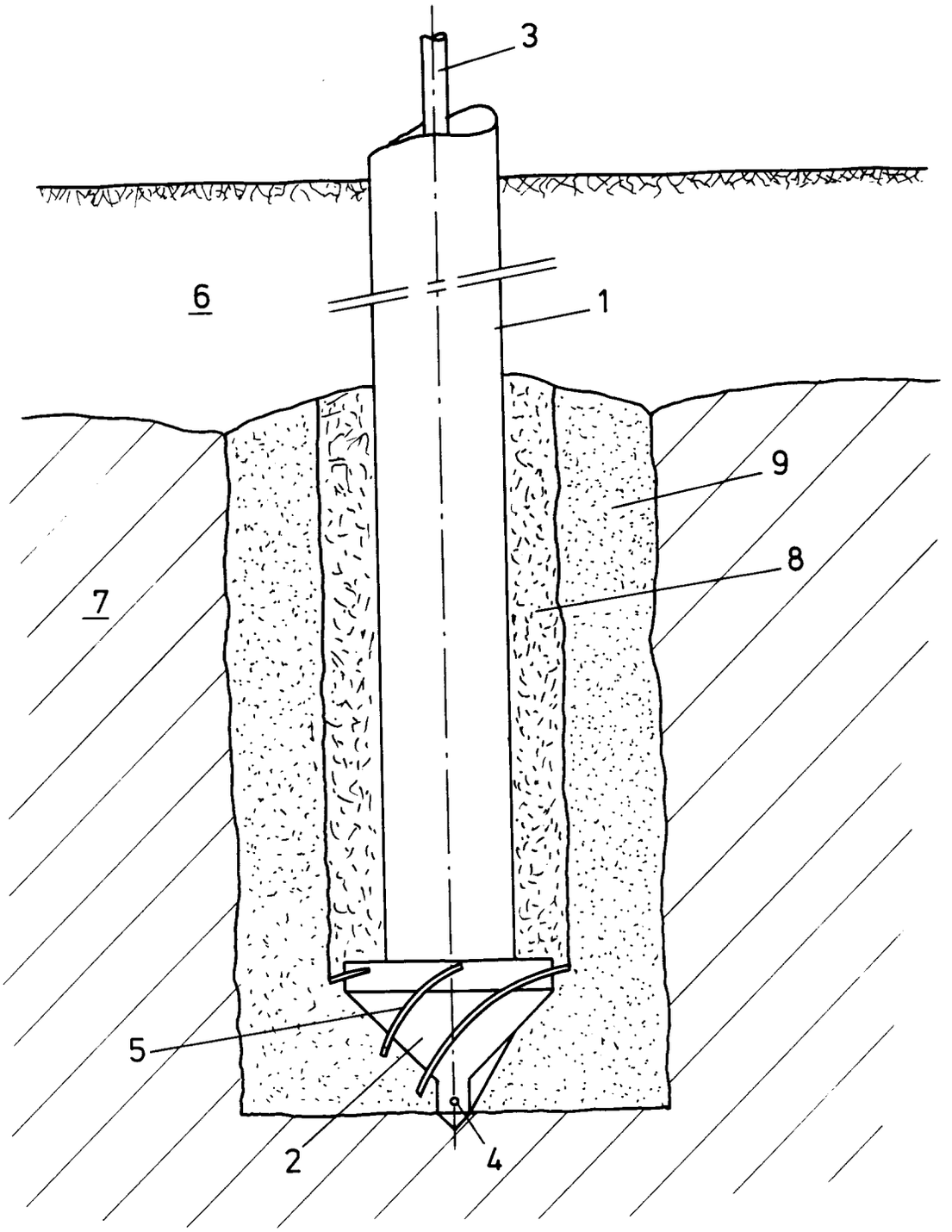

FIG.2

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EUROPEAN SEARCH REPORT

Application Number

EP 91 20 2837

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.5)
X	WO-A-8 903 458 (CRAMBES) * page 1, line 22 - page 2, line 6 * * page 2, line 33 - page 3, line 4 * * page 3, line 30 - line 32 * * page 4, line 23 - line 27 * * page 4, line 30 - line 35 * * page 5, line 16 - line 20 * * page 6, line 22 - page 7, line 33; claims 1,8,10,11,13,18; figures 1,4 *	1,2	E02D5/44 E02D5/62
A	US-A-3 802 203 (YOSHIO ICHISE) * column 1, line 47 - column 2, line 2 * * column 3, line 58 - column 4, line 16; figure 1 *	1,2	
A	WO-A-8 603 533 (CRAMBES)		

TECHNICAL FIELDS SEARCHED (Int. Cl.5)

E02D

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	09 JUNE 1992	BELLINGACCI F.

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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