

Multi-Step Grouting Apparatus and Method.

Field of the Invention

The present invention relates to a multi-step grouting apparatus and method with FRP pipe having a high strength. More particularly, the present invention relates to a multi-step grouting apparatus and method which can prevent an inflow of groundwater, and reduce a relaxation area of ground due to a tunnel excavation, and improve a bearing capacity of ground, in case of excavating a tunnel in a weathered rock including a soft alluvial soils, or earth and soil.

Background of the Invention

In modern construction works of underground structure, an auxiliary reinforcement for excavation is used to prevent a damage of an adjacent structure and to improve a safety of an underground structure, and also a combination of both methods for grouting a leakproof and a reinforcement is used to simultaneously obtain effects of leakproof and reinforcement in some cases. Generally, a representative method for an auxiliary reinforcement for excavation is a grouting method for reinforcement using a steel pipe.

Conventionally, a grouting method for reinforcement comprises the steps of boring, inserting a steel pipe, caulking, sealing and grouting, and is employed for a leakproof and a reinforcement of a soft weathered rock layer. Prior to excavating a tunnel, holes with a diameter of 125mm are bored at regular intervals around the perimeter of the tunnel. After the boring operation, a small-caliber steel pipe connected with a coupling is inserted in a bored hole, wherein injection holes are formed on the steel pipe and a rubber band is installed thereon for a backflow prevention. After inserting a steel pipe, a caulking compound is filled through a sealing hose in order to block up a grouting material coming out of the

clearance between the steel pipe and the bored hole. And in order to execute a multi-step grouting operation, a packer is inserted into a steel pipe, and the multi-step grouting operation is carried out by means of moving the packer from the inside to the outside, using an injection hole. The conventional grouting method for an auxiliary reinforcement as described above has many shortcomings. First, the steel pipe used in the conventional method thereof is only used for an auxiliary reinforcement during the construction, which means that it can not be used for a permanent reinforcement, since the steel pipe can be easily corroded in ground. Second, it takes a long time to cut off the steel pipes protruded on the surface when the next step of excavating tunnel is carried out after completing the grouting operation. Third, it is difficult to insert a steel pipe into the bored hole due to the weight of the steel pipe, in case that a depth of reinforcement depending upon the ground status and a size of a cross-sectional tunnel is big. Forth, after inserting the steel pipe, the effect of grouting in ground is decreased because the injection hole for a grouting material is blocked by contacting the steel pipe with the interior surface of bored hole due to the weight of the steel pipe, and a distribution of the grouting material is not uniform because all injection holes are not wholly opened in the step of injection.

Objects of the Invention

An object of the present invention is to provide a multi-step grouting apparatus and method with FRP(Fiberglass Reinforced Plastics) pipe in which a corrosion is not occurred, and a speed of excavating a tunnel can be improved because of an easy cutting operation.

Another object of the present invention is to provide a multi-step grouting apparatus and method with FRP pipe which has an excellent effect of leakproof by increasing the injecting amount of a grouting material into the bored hole.

A further object of the present invention is to provide a multi-step grouting apparatus and method with FRP pipe in which it is easy to handle an injection pipe due to the light weight, and there is no

phenomenon of plugging an injection hole, caused by the weight of the injection pipe, so that the efficiency of the injecting operation is excellent and the distribution of the grouting material is also uniform.

These and other objects will appear upon reading the following specification and claims and upon considering in connection therewith the attached drawing to which they relate.

Summary of the Invention

The multi-step grouting apparatus and method with FRP pipe in accordance with the present invention comprises a cylindrical injection pipe 1 in which a plurality of injection holes 3 are formed around the perimeter at regular intervals and a protruded spacer 2 having a ring configuration is formed in one body with an injection pipe 1 and a coupler 12 with an internal thread connects the injection pipes 1 having an external thread formed on both ends thereof; a backflow prevention means in order to open and close said injection hole 3; an injection hose 5 which is inserted into said injection pipe 1 and is used for injecting a grouting material; a packer 6 that is inserted into the inside of said injection pipe 2 and is used for sealing the inside of said injection pipe 2; and two sealing hoses 9 inserted into the bored hole 11, wherein one having a long length is placed on the lower part of the injection pipe 1 and extended up to the end of the bored hole 11, and the other having a short length is placed on the upper part of the injection pipe and installed up to the entrance of the bored hole 11.

A fiberglass reinforced plastics(FRP) is composed of a fiberglass and a resin, which is easy in cutting and manufacturing, and a speed of excavating a tunnel can be improved because the cutting work of FRP is easier than that of steel pipe, and also, it is easy in handling due to the light weight thereof. The chemical resistance and the corrosion resistance of FRP are excellent, so that it can be used for a permanent reinforcement as well as an auxiliary reinforcement.

Brief Description of the Drawings

In the drawing in which a preferred embodiment of the present invention is disclosed:

Fig. 1 is a cross-sectional view showing a state that an injection pipe is installed into a bored hole;

Fig. 2 is a cross-sectional view of the preferred embodiment of a multi-step grouting apparatus in accordance with the present invention;

Fig. 3 shows a front view and a side view of an injection pipe;

Fig. 4 is a perspective view showing a state that a packer and an injection hose are inserted into an injection pipe;

Fig. 5 shows a front view and a cross-sectional view of a coupler.

Detailed Description of the Invention

The present invention will be described with reference to the accompanying drawings.

A multi-step grouting apparatus and method with FRP(Fiberglass Reinforced Plastic) pipe is composed of an injection pipe 1, a backflow prevention means, an injection hose 5, a packer 6, and a sealing hose 9.

An injection pipe 1 having a cylindrical configuration is made of fiberglass reinforced plastic, wherein a plurality of injection holes 3 are formed around the perimeter at regular intervals, and a plurality of couplers 12 with an internal thread connect the injection pipes 1 having an external thread formed on both ends thereof. In the front end of the injection pipe 1, a cone can be further installed in order to easily insert it into the bored hole.

A spacer 2 having a ring configuration is formed in one body with an injection pipe 1, wherein the spacer 2 is protruded and formed at regular intervals. When the injection pipe 1 is inserted into a bored hole 11, the spacer 2 plays a role to keep a clearance between an injection hole 3 and an interior surface of the bored hole 11, so that the injection of a grouting material is not obstructed and the injection pipe 1 can be placed in the nearest center of the bored hole 11. Also, the spacer 2 is installed in front of an injection hole 3 to the inserting direction of the injection pipe 1 into the bored hole 11. Therefore, when the injection pipe

1 is inserted into the bored hole 11, the spacer 2 prevent a damage of a rubber band 4 used for a backflow prevention means, which is caused by contacting the rubber band 4 with the ununiform interior surface of the bored hole 11, so that the injection hole 3 is prevented from clogging.

A backflow prevention means is installed in order to prevent an inflow of earth and soil, or impurities into an injection hole 3 in case of inserting an injection pipe 1 into a bored hole 11, and a flowing backward of a grouting material into the injection pipe 1. A rubber band 4 is used as a backflow prevention means. The rubber band 4 is set on the exterior surface of an injection pipe 1, so that the rubber band 4 plugs up the injection hole 4. By the increase of the injection pressure of a grouting material, a gap is formed between the rubber band 4 and the injection hole 3, and thereby the grouting material is filled in a void of ground or crack. Only one rubber band can be used, and also a plurality of rubber bands can be used by overlapping.

Pinholes can be further formed in the rubber band 4. The pinholes are normally closed. But, when the injection pressure is increased, the rubber band 4 is expanded, therefore, the pinholes are getting larger, and a grouting material flows out therethrough, whereby the efficiency of the injection of a grouting material can be improved. The rubber band type 4 of a backflow prevention means has the advantages in manufacturing, installing, and significant cost savings.

An injection hose 5 is installed in the inside of an injection pipe 1, and a grouting material is inserted into the inside of the injection pipe 1 by means of using the injection hose 5. A packer 6 is installed at the end of the injection hose 5.

A packer 6 is composed of two guard rings 8 and a pipe installed between the guard rings, and the injection hose 5 is passed therethrough. The pipe 7 is connected with an air injecting pipe. The pipe can be expanded and contracted by a compressed air, so that a clearance between the pipe 7 and the interior surface of the injection pipe 1 is sealed by means of blowing a compressed air in the pipe 7. Accordingly, a grouting material injected through the injection hose 5, which is

extended by passing through the packer 6, is blocked by the pipe 7, thereby the grouting material does not flow backward to the entrance of the injection pipe 1. After installing the pipe 7, the grouting material is injected through the injection hole 3, so that a backflow of the grouting material in the injection pipe 1 is prevented and the grouting material can be filled from the inside of the bored hole 11. After completing the injection to some degree, the pipe is contracted again and the injection hose 5 having the packer 6 is moved toward the entrance, and the pipe 7 is expanded again to block the injection pipe 1, thereafter the grouting material is injected. Thus, the grouting material is filled from the end of the bored hole 11 by a method of a multi-step injection.

A diameter of the guard ring 8 is smaller than that of the inside diameter of the injection pipe 1, therefore the guard ring 8 can be freely moved therein. When the injection hose 5 with the contracted pipe 7 is moved in the injection pipe 1, the guard ring plays a role to protect the pipe 7, not to contact with the wall of the injection pipe 1.

Two sealing hoses 9 are inserted into a bored hole 11. One of the sealing hose 9 having a long length is placed at the lower part of the injection pipe 1, which is extended to the end of the bored hole 11, and the other having a short length in comparison with the long sealing hose is placed at the upper part, which is extended to the entrance of the bored hole 11. A sealing compound is filled in clearance between the injection pipe 1 and the bored hole 11 through the sealing hose 9. The sealing compound is filled from the inside of the bored hole 11 to the entrance thereof through the long sealing hose. When the sealing compound is filled up to the entrance of the bored hole, the sealing compound is overflowed through the short sealing hose 9 placed at the upper part of the injection pipe 1. The injected sealing compound plays a role to push out the impurities remained in the bored hole 11, and to block water percolating into the bored hole 11, and to hold a position of the injection pipe 1, so that it makes the injecting operation of a grouting material easy. Also, the sealing compound is mixed with the injected grouting material, and solidified, and acts as a stabilizer liquid.

A grouting process by multi-step in accordance with the present invention is described as follows.

First of all, the excavating operation is carried out upwardly against the excavation surface. The injection pipe 1 is prepared to be one body with a spacer 2 having a ring configuration at factory. A backflow prevention means such as a rubber band 4 is installed on an injection hole 3 formed in an injection pipe 1, and then the injection pipes 1 are connected by means of a plurality of couplers 12. After the excavating operation, the injection pipe 1 is inserted into the bored hole 11. Subsequently, two sealing hoses 9 are inserted into the bored hole 11. One is placed on the lower part of the injection pipe 1 and extended up to the end of the bored hole 11. The other is placed on the upper part of the injection pipe, and installed up to the entrance of the bored hole 11. After the completion of inserting the injection pipe 1 and sealing hose 9, the entrance of the bored hole 11 is sealed by using a caulking compound. A sealing compound is injected through the sealing hose 9 which is extended up to the end of the bored hole 11. When the sealing compound is overflowed through the sealing hose 9 which is installed up to the entrance of the bored hole 11, the injecting operation of the sealing compound is stopped. When the sealing compound is solidified to some degree, the injection hose 5 in which a packer 6 is installed at the end thereof is inserted into the injection pipe 1, followed by injecting a grouting material. A pipe 7 placed at the center of the packer 6 is expanded by a compressed air, thereby the interior wall of the injection pipe 1 is sealed. The grouting material injected through the injection hose 5, which is extended through the packer 6, is blocked by the pipe 7, therefore, the grouting material is injected through the only injection hole 3 after installing the pipe 7. When the injection of the grouting material is completed, the pipe 7 is contracted, thereafter moving the injection hose 5 toward the outside, and the pipe is expanded again in order to seal the injection pipe 1, followed by injecting the grouting material. As described above, the injecting operation of the grouting material is a multi-step injection which is executed from the end of the bored hole 11. The

injected grouting material is first filled in the inside of the injection pipe 1, thereafter flowing out through the injection hole 3, and percolated into ground, and mixed with a sealing compound filled in the bored hole 11, and solidified. The present invention can be applied for the use of a soil nailing as well as for reinforcing the ground.

A fiberglass reinforced plastics(FRP) is composed of a fiberglass and a resin, which is easy in cutting and manufacturing, and a speed of excavating a tunnel can be improved because the cutting work of FRP is easier than that of steel pipe, and also, it is easy in handling due to the light weight thereof.

The chemical resistance and the corrosion resistance of FRP are excellent, so that it can be used for a permanent reinforcement as well as an auxiliary reinforcement.

Also, a multi-step grouting apparatus in accordance with the present invention provides that a separator is prepared to be one body with a FRP pipe, which protects a rubber band, and also, by using the separator, an injection pipe is placed at the center of a bored hole, so that the injection pipe is not directly contact with the interior wall of the bored hole. Therefore, it makes the injecting operation of a grouting material easy, and also the distribution of the grouting material in the inside of the bored hole is uniform.

The present invention can be easily carried out by an ordinary skilled person in the art. Many modifications and changes may be deemed to be within the scope of the present invention as defined in the following claims.

What is claimed is:

1. A multi-step grouting apparatus comprising:
 - a cylindrical injection pipe 1 in which a plurality of injection holes 3 are formed around the perimeter at regular intervals and a plurality of protruded spacers 2 having a ring configuration is formed in one body with an injection pipe 1 and a coupler 12 with an internal thread connects the injection pipes 1 having an external thread formed on both ends thereof;
 - a backflow prevention means to open and close said injection hole 3;
 - an injection hose 5 that is inserted into said injection pipe 1 and is used for injecting a grouting material;
 - a packer 6 that is inserted into the inside of said injection pipe 2 and is used for sealing the inside of said injection pipe 2; and
 - two sealing hoses 9 inserted into the bored hole 11, wherein one having a long length is placed on the lower part of the injection pipe 1 and extended up to the end of the bored hole 11, and the other having a short length is placed on the upper part of the injection pipe and installed up to the entrance the bored hole 11.
2. The apparatus as defined in claim 1, wherein said injection pipe 1 is made of fiberglass reinforced plastics(FRP) having a strong strength.
3. The apparatus as defined in claim 1, wherein said backflow prevention means is a rubber band 4 installed in the outside of said injection hole 3.
4. The apparatus as defined in claim 3, wherein said rubber band 4 further includes pinholes.
5. The apparatus as defined in claim 3, wherein said rubber band is composed of a plurality of narrow rubber bands.
6. The apparatus as defined in claim 1, wherein said spacer 2 is installed in front of said injection hole 3 to the inserting direction of said injection pipe



1 into the bored hole 11.

7. A method for grouting comprising the steps of:

installing a backflow prevention means on an injection hole 3 of an injection pipe 1 of claim 1 or claim 2, and connecting a plurality of said injection pipes 1 by using a plurality of couplers 12 to fit in the depth of a bored hole 11;

inserting the connected injection pipe 1 into said bored hole 11;

inserting two sealing hoses 9 of claim 1 into said bored hole 11, wherein a long sealing hose 9 is inserted up to the end thereof and a short sealing hose is inserted up to the entrance thereof;

sealing the entrance of said bored hole 11 by using a caulking compound 10;

injecting a sealing compound through said sealing hose 9 which is inserted up to the end of said bored hole 11 until said sealing compound is overflowed through the sealing hose inserted at the entrance of said bored hole 11;

inserting an injection hose 5 having a packer 6 of claim 1 into said injection pipe 5;

blocking said injection pipe 1 by using said packer 6, thereafter injecting a grouting material through said injection hose 5; and

repeating the steps of moving said packer 6 at a definite interval toward the outside, thereafter blocking again said injection pipe 1, followed by injecting said grouting material, up to the entrance of said bored hole 11.

