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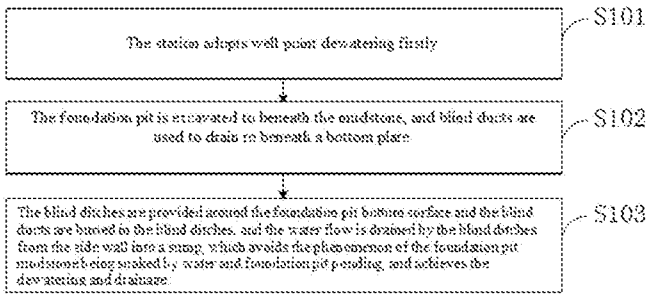
(54) **New comprehensive dewatering and drainage method and drainage device for mudstone subway station.**

(57) The present invention belongs to the technical field of dewatering and drainage and discloses a new comprehensive dewatering and drainage method and drainage device for mudstone subway station. The present invention adopts well point dewatering and foundation pit side wall drainage to the bottom plate, and adopts the base open drainage method to solve the dewatering problem, which can avoid the phenomenon of foundation pit mudstone being soaked by water and foundation pit ponding, so as to effectively achieve the dewatering and drainage effect.



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NEW COMPREHENSIVE DEWATERING AND DRAINAGE METHOD AND DRAINAGE DEVICE FOR MUDSTONE SUBWAY STATION

BACKGROUND

Field of Invention

This invention belongs to the technical field of dewatering and drainage, particularly to a new comprehensive dewatering and drainage method and drainage device for mudstone subway station.

Background of the Invention

In recent years, the foundation pit engineering got rapid developed in China, and a large amount of engineering practices enrich and improve the technical level in the field of foundation pit engineering in China. However, the foundation pit engineering is a subject with extremely strong practicality and experience. There are both large amounts of successful experiences and lessons from failure and even problems to be further solved in the engineering practices from recent 10 more years. In the process of foundation pit excavation, because the aquifer of soil is cut off, groundwater will inevitably continuously infiltrate into the foundation pit, which leads to the problem of foundation pit dewatering. Foundation pit dewatering adopts catchment open drainage or well point dewatering. It has become an important aspect of deep foundation pit excavation and support engineering how to control groundwater and reduce its negative impact on foundation pit excavation and surrounding environment. The Jincheng Avenue Station is located at the II grade terrace of Minjiang River System in Chuanxi Plain,

with simple landform, open and flat terrain. The foundation pit is constructed by open-cut method, and the soil layer is miscellaneous fill, plain fill, sand gravels and mudstone layer from top to bottom. The underlying bedrock of the station is Cretaceous Guankou Formation aubergine, maroon mudstone. This rock mass is compact in structure, low in natural porosity, and low in water permeability. However, the mudstone is easy to soften and disintegrate in water, resulting in the instability and collapse of the foundation pit. The station adopts the well point dewatering outside the pits. Due to the impermeable mudstone and the existence of fissure water, the dewatering is insufficient, resulting in the groundwater flowing down along the side wall of the foundation pit and serious ponding in the basement.

From the aforementioned analysis, the problems and drawbacks in the prior art are that:

the station adopts well points dewatering outside the pit. Due to the impermeable mudstone and the existence of fissure water, the dewatering is insufficient, resulting in the groundwater flowing down along the side wall of the foundation pit and serious ponding in the basement.

SUMMARY

In view of the problems existing in the prior art, this invention provides a new comprehensive dewatering and drainage method for mudstone subway station, which adopts well point dewatering and foundation pit side wall drainage to the bottom plate, and then adopts the base open drainage method for dewatering, specifically including:

Step one, the station adopts well point dewatering firstly;

Step two, the foundation pit is excavated to beneath the mudstone, and blind ducts are used to drain to beneath the bottom plate;

Step three, the blind ditches are provided and the blind ducts are buried around the foundation pit bottom surface, and the water flow is drained from the side wall into the sump, which avoids the phenomenon that the mudstone of the foundation pit is soaked in water and the water is ponding in the foundation pit, so as to effectively achieve the dewatering and drainage effect.

This invention also provides a new comprehensive dewatering and drainage device for mudstone subway station, having:

the foundation pit bottom surface;

wherein the said foundation pit bottom surface is provided with a blind ditch, and the horizontal blind ducts and the vertical blind ducts are embedded in the said blind ditch;

a water collecting ditch is arranged in the foundation pit, and the said water collecting ditch is connected with a water reservoir well.

ADVANTAGEOUS EFFECTS

This invention adopts well point dewatering and foundation pit side wall drainage to the bottom plate, and then adopts the base open drainage method to solve the dewatering problem, which can avoid the phenomenon of foundation pit mudstone being soaked by water and foundation pit ponding, so as to effectively achieve the dewatering and drainage effect.

In the current construction of subway project, the dewatering of deep foundation pit is an important earlier stage work to ensure the follow-up earthwork, net spraying operation, waterproof layer laying, and structural concrete construction, which is particularly crucial to the dewatering effect of the deep foundation pit without foundation pit external waterproof curtain measure, otherwise, the earthwork with water will occur, the material consumption of the net spraying will exceed the standard, the base will be

soaked, over-excavated, and lose stability, the instability of structural concrete quality and other problems of safety and quality and cost waste will occur. Therefore, foundation pit dewatering must be fully reasonable, especially under complex geological conditions, the measures for deep foundation pit dewatering must be comprehensive. Combining with practical example of comprehensive harnessing water project of Jincheng Avenue station of Chengdu Metro Line 9 with deep foundation pit under complex geological conditions of impermeable mudstone and high fissure water developed, this invention discusses the engineering characteristics, construction principle, construction technology and key points of construction operation in detail.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a flowchart of new comprehensive dewatering and drainage method for mudstone subway station provided by an example of this invention;

Fig. 2 is a schematic diagram of new comprehensive dewatering and drainage device for mudstone subway station provided by an example of this invention;

Fig. 3 is an installation schematic diagram of drain pipe provided by an example of this invention;

Fig. 4 is a flowchart of comprehensive harnessing water project of subway foundation pit provided by an example of this invention;

Fig. 5 is a diagram for surface water closure provided by an example of this invention;

In Figs. 2, 3, 5: 1, blind ditch at the pit bottom; 2, foundation pit bottom surface; 3, drainage ditch; 4, excavation face; 5, water reservoir well; 6,

vertical blind ducts; 7, horizontal blind ducts; 8, drain pipe; 9, surface of concrete spray; 10, larger area of water impermeable;

Fig. 6 is a structural schematic diagram of dewatering well at Jincheng Avenue station provided by an example of this invention;

Fig. 7 is a flowchart of the construction process of the dewatering well provided by an exampleof this invention;

Fig. 8 is a schematic diagram of water guide and drainage at the interface between sand gravels and mudstone provided by an example of this invention;

DETAILED DESCRIPTION OF THE EMBODYMENTS

In view of the problems existing in the prior art, this invention provides a new comprehensive dewatering and drainage method for mudstone subway station, and this invention is described in detail in combination with the attached drawings.

As illustrated in Fig. 1, the new comprehensive dewatering and drainage method for mudstone subway station provided by the example of this invention comprises:

S101, the station adopts well point dewatering firstly;

S102, the foundation pit is excavated to beneath the mudstone, and blind ducts are used to drain to beneath the bottom plate;

S103, the blind ditches are provided around the foundation pit bottom surface and the blind ducts are buried in the blind ditches, and the water flow drained by the blind ditches from the side wall into the sump, which avoids the phenomenon of foundation pit mudstone being soaked by water and water ponding in the foundation pit, and achieves the dewatering and drainage.

Fig. 2 is the new comprehensive dewatering and drainage device for mudstone subway station provided by an example of this invention, which comprises:

blind ditch at the pit bottom 1, foundation pit bottom surface 2, drainage ditch 3, excavation face 4, water reservoir well 5, vertical blind ducts 6, horizontal blind ducts 7, drain pipe 8, surface of concrete spray 9, larger area of water impermeable 10. The foundation pit bottom surface 2 is provided with a blind ditch, and the horizontal blind ducts 7 and the vertical blind ducts 6 are embedded in the blind ditch; a water collecting ditch is arranged in the foundation pit, and the water collecting ditch is connected with a water reservoir well.

Fig. 3 is an installation schematic diagram of drain pipe provided by an example of this invention;

This invention mainly adopts well point dewatering and foundation pit side wall drainage to the bottom plate, and then adopts the base open drainage method to solve the dewatering problem.

The deep well pipe well dewatering is adopted in the pipe well dewatering engineering, and the technology of making holes by auger drill is adopted in the well holes, with the average distance of 20 m. The depth of dewatering well is 22.5 m, the center point error of pipe well is $\pm$20 mm, the perpendicularity error $\leqslant$1%, and a grit chamber is provided according to the actual arrangement of the site. The well pipe is composed of multiple sections of reinforced concrete pipes with inner diameter of 300 mm, outer diameter of 600 mm and length of 2.5 m for each section. The lower part is composed of four sections of filter pipes and one section of grit pipe, which are 200 mm above the ground; the filter section is made up of Φ300 mm reinforced concrete pipe full of water filtering holes, as well as its outer

covering of wire mesh, dense mesh and sparse mesh sand filtering water-permeable layer. After the well pipe is hoisted and placed, filtration media is evenly placed along the periphery of the well pipe, and the filtration media is the gravel with diameter of 3-7 mm. When the filtration media is filled to about 2 m below the wellhead, clay is filled to tamp and flat. The well is washed with air compressor and piston jointly, wherein using air compressor to wash well, and then using piston to wash well. The sand content is monitored every day to make sure the sand content of the pumped water meet the following requirement: ① the sand content of the fine sand is less than 1/10000; ② the sand content of the medium sand is less than1/20000; ③ the sand content of the coarse sand is less than 1/50000.

Although the foundation pit with water-pumping open drainage in the foundation pit adopts the borehole piles with net sprayed concrete as the enclosing structure. Due to the special hydrogeology in the station area, a certain amounts of groundwater and ground precipitation exist during the excavation. If necessary, a water collecting ditch shall be arranged in the foundation pit, through which the water will flow into the water reservoir well, and then the water will be discharged to the ground drainage system around the foundation pit by mud pump, and discharged into the rainwater pipe after sedimentation. During the rainy season excavation, the longitudinal slope surface is covered with color striped waterproof cloth, and the rainwater is collected to the lowest water reservoir well, and is open-discharged to the ground drainage system by water pump. The excavation needs to be stopped when the foundation pit is excavated by sections to 30 cm of the base, and the grounding device shall be constructed. During this period, the exposed surface of the base is closed by the method of covering with the plastic geomembrane. Two drainage ditches are set in each section

of foundation pit, and horizontal water ditches are set every 15 m or so. Ponding wells are staggered at the intersection of horizontal and vertical water ditches, and water is open-discharged to the ground drainage system by water pump. The specific requirements are as follows: ① the water collecting ditches are lower than the bottom surface of the foundation pit, and are square open ditches with depth of 0.3 m and width of 0.3 m, and longitudinal slopes of 0.2% - 0.5% are set at the bottom of the ditches, so that the water flow will not be blocked. ② The water collecting ditches are set on both sides of the foundation pit, about 2.5 m away from the guard post. ③ The section of water reservoir well is 1 m (longth) × 1 m (width) × 1.0 m (depth). The well wall is reinforced with bamboo cage and wooden board, and the centrifugal pump is used for pumping and draining from the well. ④ When making the bottom slab bedding concrete, the ditches and the ponding wells are densely backfilled with the bedding concrete, and then the bedding is constructed. In the process of foundation pit excavation, in order to prevent seepage phenomenon, anti-leakage measures are set after drainage and at the bottom of the water reservoir well wall: applying blocking materials (plugging liquid and rapid hardening cement). Drain holes are arranged at the water outlet between piles, and the Φ 40 mm PVC pipes are adopted and are fixed on the inner side of the reinforcing mesh with a spacing of 1.6m * 1.6m, and the places with large water seepage shall be densely arranged. When spraying concrete, the pipe orifice shall be blocked to prevent concrete from entering the pipe. When the seepage is large, the Φ 40 mm PVC pipe is required to be arranged inside of the spraying concrete to drain the seepage water to the drainage ditch at the bottom of the foundation pit.

Φ20 plastic drain pipes are set at the seepage places on the side wall of

the foundation pit, and the drain pipes are properly densely set in the sand and gravel layer with concentrated discharge. The drain pipe is pre-embedded in the soil for 80 cm, and the external part is 5cm exposed from the concrete spraying surface. The drain pipe surface in the soil is drilled with drain holes to drain the seepage water out of the drain pipe, and the hole spacing is 5cm * 5cm, and the drain pipe is wrapped with geotextile to prevent gravels from blocking the drain holes.

After the Φ32 horizontal blind ducts are used to collect the leakage water in the place with large water volume, the Φ40 vertical blind ducts are used to drain water into the drainage ditch under the foundation pit or the blind ditch at the bottom of the foundation pit. The horizontal blind ducts and the vertical blind ducts are embedded in the soil by slotting on the excavation surface, and the external exposed surfaces of the blind ducts are flush with the excavation surface. The blind ditch at the bottom of foundation pit is embedded 30 cm below the foundation pit bottom, and the diameter is determined according to the amount of water, and the water catchment in blind ditch is directly discharged into the water reservoir well. The water ponding in the drainage ditch is pumped out to the sedimentation tank outside the foundation pit by the water pump, and is discharged into the municipal pipeline after reaching the discharge standard after sedimentation.

The technical solution of the present invention will be further described in combination with the example below.

I, SUMMARY OF PROJECT

Jincheng Avenue Station of Chengdu Metro Line 9 phase one project is a 3-storey underground station, which transfers with Line 5 in the station. The length of the main body is 465 m (including the length at the nodes), the width of the station standard section is 23.3 m, and the average depth is about

27 m. The structural form is double-column and three-span cast-in-place frame structure. The center mileage position is about the average thickness of the covering soil of this station, which is about 4.691 m.

The Jincheng Avenue Subway Station is located at the II grade terrace of Minjiang River System in Chuanxi Plain, with simple landform, open and flat terrain. The foundation pit is constructed by open-cut method, and the soil layer is miscellaneous fill, plain fill, sand gravels and mudstone layer from top to bottom. The underlying bedrock of the station is Cretaceous Guankou Formation aubergine, maroon mudstone. This rock mass is compact in structure, low in natural porosity, and low in water permeability. However, the mudstone is easy to soften and disintegrate in water, resulting in the instability and collapse of the foundation pit. Taking the standard section as an example, the geological conditions of the station are as follows: miscellaneous fill soil layer is at 0-4 m below the surface, plain soil layer is at 4-11.1 m below the surface, sandy gravel layer is at 11.1-17.1 m below the surface, mudstone layer is at 16.9 m to basement, and the phreatic line is 6.6 m below the ground. It is summarized that the permeable layer is above 16.9 m, and the above groundwater can be discharged by well point dewatering. The underground below 16.9 m is mudstone impermeable layer, and the groundwater cannot be discharged by well point dewatering outside the pit, and the groundwater will flow into the foundation pit along the mudstone fissure , which has a great adverse effect on the follow-up process.

II, CHARACTERISTICS OF FOUNDATION PIT DEWATERING PROJECT

The main structure of the station is in mudstone, which has the characteristics of weak expandability, impermeability and high fissure water developed. Strong weathered mudstone is extremely soft. Under the action

of groundwater, mudstone is easy to soften and collapse, and the overlying soil layer of foundation pit is easy to slide along the weak surface of mudstone (weathered layer), resulting in foundation pit instability and collapse. Because the mudstone is impermeable layer, and its internal irregular fissures carry water layer, one-time drainage cannot solve the problem of mudstone dewatering. In order to ensure the stability of the foundation pit, it is necessary to adopt the combination of well point dewatering and foundation pit side wall draining with open drainage and base catchment and other measures to solve the problem of foundation pit dewatering.

III WORKING PRICIPLE

The research on comprehensive water control technology of impermeable mudstone of subway deep foundation pit and high fissure water developed foundation pit is mainly suitable for the situation that the upper layer is highly permeable geology and the lower layer is impermeable geology, the groundwater cannot be discharged by outside pit dewatering at one time. The water control methods of dewatering outside the pit, drainage at joints, drainage of impermeable fissure water and collection and drainage inside the pit are needed to ensure the economy, safety and quality of subsequent construction.

IV, METHOD OF CONSTRUCTION

As illustrated in Fig. 4, a flowchart of comprehensive harnessing water project of subway foundation pit is provided by an example of this invention. According to the geological characteristics of Jincheng Avenue Station of Metro Line 9, the construction sequence of foundation pit overall dewatering treatment is: surface water interception and drainage; well point dewatering

outside the foundation pit; open water drainage from the side wall of the foundation pit; drainage from the base drainage ditch and water reservoir well.

1. Surface water interception and drainage

1.1 Setting of surface water seal and drainage

Jincheng Avenue station will carry out concrete hardening treatment for all construction sites inside the enclosure and outside the foundation pit. The drainage ditch is set within 1 m around the enclosure. The surface dewatering and construction flushing water flow to the drainage ditch near the construction enclosure and then to the three-stage sedimentation tank, and then flow into the municipal pipe network after sedimentation.

1.2 Setting of the surface water ditch

As shown in Fig. 5, a diagram for surface water closure is provided by an example of this invention. Drainage ditches with 300×300 mm (width × depth) are arranged around the retaining wall of the foundation pit. The internal corners of the drainage ditch are caulked for waterproofing, and a sump is set at the lowest location. The water is pumped by submersible pumps from the sump to the drainage ditch near the enclosure, and then discharged into the municipal pipe network by the drainage ditch system. The drainage direction of the hardened site deviates from the foundation pit, and the retaining wall of Jincheng Avenue station is 300 mm higher than the hardened elevation of the site, which can prevent the surface water from pouring into the foundation pit.

2. Well point dewatering outside the foundation pit

Through the calculation of water inflow, considering the multi-well effect and regional construction experience, Jincheng Avenue station has been laid with 48 dewatering wells along the periphery of the station, with

the dewatering well center spacing of 25 m, and the two sides of the foundation pit are arranged in quincunx. The hole diameter of the dewatering well is 600 mm. The inner well pipe in the dewatering well is assembled by several sections of reinforced concrete, with an inside diameter of 300 mm and an outside diameter of 370 mm. The well pipes are divided into two types: the casing pipes and the filter pipes, and the length of each well pipe is 2.5 m. Considering the dewatering to the interface between sand gravels and mudstone, and the mudstone layer being 16.9 m underground, the depth of the dewatering well is designed to be 22.5 m, and two sand-settling pipes are reserved under the interface.

As illustrated in Fig. 6, a structural schematic diagram of dewatering well at Jincheng Avenue station is provided by an example of this invention. The filter pipes are used for the pebble layer in the dewatering well, and the rest are casing pipes. The outer skin of the filter pipe needs to be wrapped with two layers of 300 g/㎡ nonwoven cloth. After the completion of well pipes installation, manually packing should be carried out around the well pipes, the packing shall be conducted uniformly around the well pipes. The filter material is gravel with a diameter of 3-7 mm. See Table 1 for specific parameters of dewatering wells.

Table 1 Dewatering Well Design Parameter Table

Project Name	Type of Well	Well-Inside Diameter (mm)	Diameter of Filter Material	Well Depth (m)	Well Structure
Jincheng Avenue Station	Pipe well	300	3-7 mm	22.5	Totally 9 segemts of pipes (2 segments of sand-settling pipes , 3 segments of filter pipes， 4 segments of casing pipes)

2.1 Construction procedures of dewatering wells

As illustrated in Fig. 7, a flowchart of the construction process of the dewatering well is provided by an example of this invention.

2.2 Measure and set out the well location

After the location of dewatering well is arranged, measuring and setting the line for each dewatering well is. When there are obstacles, the location of dewatering well is adjusted locally according to the actual situation.

2.3 Embedding the opening protective pipe

Before drilling for dewatering well, the opening protective pipes are embedded firstly. The opening protective pipes are inserted into undisturbed soil, and the outer part of the pipe shall be sealed and closed. Clay soil is used for sealing to prevent slurry from turning out during construction. The elevation of the upper opening of the opening protective pipe is 0.2 m higher than the surface plane.

2.4 Installing the drilling rig

The drilling rig is installed flatly, reliably and stably, and the installation is carried out according to the plane position, so as to keep the connection line of the center of each component in the center of the dewatering well, and ensure the accuracy of the position and verticality.

2.5 Forming hole

The selected machine is steel percussion drilling rig. The drill bit of the drilling rig is determined according to the opening protective pipe, which is 20 cm smaller than the opening protective pipe. After the percussion drilling rig is installed and accurately located, the center of the hammer and the center of the protective cylinder are adjusted to be on the same line, and the horizontal position deviation is $\leqslant \pm$ 20 mm. When punching holes, low

hammer intensive impact should be used for several times, and clay slurry should be added and stuffed to protect the wall. The selection of slurry density and stroke are shown in Table 2 below. Repeated impact can make the inside wall of the well compacted. Speed up the impact speed and increase the stroke only after the repeated process operation until 3-4 m below the opening protective pipe, and the impact hammer is raised to more than 2.0 m to start normal continuous impact. During the impact process, the residual slag in the dewatering well is discharged out of the hole in time to avoid drill stuck.

Table 2 Selection Table of Stroke in Different Soil Layer and Slurry Density

Order	Item	Stroke(m)	slurry Density(t/m3)	Remarks
1	within 3 m from the ground to the lower opening of the opening protective cylinder	0.9-1.1	1.1-1.3	When the soil layer is poor, the slurry density should be increased, and small pieces of stones and clay clods should be added if necessary.
2	clay	1-2	clean water	Thinning slurry, and clean the mud clods on the bit frequently.
3	sandy soil	1-2	1.3-1.5	Dispose clay clods, and flush frequently for slag discharging, and prevent the collapse of holes.
4	weathered rock	1-4	1.2-1.4	Increase the impact force, discharge the slag frequently.
5	backfill the collapsed hole and reform the hole	1	1.3-1.5	Repeat the impact, add clay clods and pieces of stones.

The verticality of the hole of dewatering well is checked every 2m during drilling. In case of position deviation and verticality inclination, drilling shall be stopped immediately and effective corrective measures shall be taken. As the stratum with junction of different sites and boulders and other prone to deflection, it is necessary to tap repeatedly with low hammer and impact discontinuously, so as to maintain the verticality of the hole and the effect of forming hole.

After forming hole, the hole depth is checked immediately to ensure that the hole depth reaches the design elevation, and the residue in the holes shall be removed.

2.6 Cleaning hole

After punching to form hole, the residue and slurry in the hole are cleaned before the installation of casing pipes. Clean water with pressure is used for reverse flushing from bottom to top during cleaning hole. The operation is repeated until the water returned from the hole is roughly fresh.

2.7 Installing the casing pipes

The length of the well pipe is 2.5 m, and the two ends of the prefabricated pipe are equipped with 100 mm of long steel rings. And the method of purchasing finished products and transporting to the site is adopted. The well pipes and filter pipes are purchased according to the quantity in the scheme, and the 25 t truck crane is used for sectional hoisting and installation. Each section of 2.5 m well pipe is connected by lap welding. A well pipe installation platform is set above the dewatering well hole. Two 22a I-beams are used as carrying pole beam(s). After 80% of the length of the first section of well pipe is placed in the hole, the carrying pole beam is used to operate the platform to fix the well pipe, then the second section of well pipe is lifted, the hoisting height and position of the well pipe is adjusted

to make it closely butt with the first section of well pipe, and the steel rings at the interface is welded. After welding, the carrying pole beam fixation is loosened, and fixation is performed again after the second well pipe is about 50 cm out of the platform, and then the third well pipe is lifted. The follow-up process is in the same procedure until all the well pipes are installed. In the process of installation, if this section is a filter pipe, two layers of filter cloth should be wrapped at the same time. The well pipes are lowered slowly to avoid colliding with the well wall and keep perpendicularity. The well pipes are 20 cm higher than the ground after installation.

2.8 Filling the filter material

After the installation of dewatering well, the operation platform continues to fix the well pipes to ensure the verticality and stability of the well pipes. The gravels with particle size of 3-7 mm are transported to 1.5 m location around the wellhead by forklift, and are put evenly around the wellhead by manual operation. The gravels are stopped to put until 1.5 m away from the ground line, and the remaining 1.5 m is filled with clay and tamped manually to prevent surface water from infiltrating into the dewatering well.

2.9 Well washing for dewatering well

Within 8 hours after the completion of all the above processes, the completed dewatering well is refilled with clean water, and the deep well water pump meeting the delivery lift is used for pumping water. The process is carried out circularly until the well water pumped out is clean water.

2.10 Water pump installation and test pumping

After the completion of the above procedures, the water pump is installed. Firstly, clean water pump with 35 meters of delivery lift is selected. The water pump is equipped with automatic induction device to intelligently control the water pumping. The water pump circuit is well protected by

outside wrapping. Due to the long time dewatering in the station, in order to avoid damaging the water pumping pipe due to the water blasting effect and causing frequent replacement, galvanized steel pipe(s) is uniformly used for the water pumping pipe(s), and the water pumping pipe outside the well is connected with the surrounding drainage ditch. The pipe orifice is provided with an anti-conduit cover plate, and the signs are designed and showed on each well cover. After the installation of the pumping and drainage system, the test pumping is started.

3．Water guide and drainage of the side wall of foundation pit

3.1 Method of strand-shaped crevice water drainage at the interface between sand gravels and mudstone and mudstone

As illustrated in Fig. 8, a schematic diagram of water guide and drainage at the interface between sand gravels and mudstone is provided by an example of this invention. It is found from the actual on-site examination that the water leakage of the side wall of the foundation pit is mainly concentrated at the interface between sand gravels and mudstone. When the foundation pit is excavated to the interface between sand gravels and mudstone, drainage holes are drilled at the water outlet between piles at the interface, and small drilling equipment is used for drilling Φ42 holes with the drilling angle as 10 °， so as to ensure the slope of drainage, and install Φ32 mm steel flower tube, and to plug the gaps with accelerator at the buried position. The length of the steel flower tube is 85 cm, of which the tube in the front 80 cm section is perforated on the upper part, with the holes spacing of 5 cm, and the holes are arranged in quincunx shape. After wrapping the non-woven cloth, the perforated section is embedded in the side wall of the foundation pit, and a 5 cm non-perforated steel pipe at the end is reserved to connect steel wire tube in Dn40 diameter. The steel wire tube has strength to

prevent the spray concrete from breaking through and squeezing the drinking passages. The steel wire tube is fixed on the steel mesh to prevent the displacement of the steel pipe and the loose connection caused by spray concrete. The horizontal spacing of the steel flower pipe arrangement is 1.5 m * 1.5 m, and the place with large water seepage should be densely arranged. The steel wire tube is 30 cm longer than the bottom of the spray concrete anchor surface, and the pipe orifice is blocked to prevent the steel wire tube from being blocked by shotcrete, so as to continue to downwardly connect the water diversion during the excavation of the lower foundation pit. The steel wire tube reserved for drainage at the upper layer is lengthened in every excavation until it is connected to the temporary drainage ditch at the bottom of the foundation pit, and then the foundation pit is pumped out by the base drainage system.

3.2 Operation method of scattered crevice water in the side wall of the foundation pit

As illustrated in Fig. 2, an arrangement diagram of dendritic water drainage network pipes is provided by an example of this invention. When there is scattered leakage water on the side wall of the foundation pit, it is necessary to collect the scattered leakage water and form a diversion channel behind the shotcrete anchor face. Otherwise, the leakage of groundwater from the shotcrete anchor face will have a great impact on the subsequent construction. After several discussions, it is decided to use the permeable blind pipe(s). The characteristics of the permeable blind pipe are: strong toughness and not easy to be damaged by shotcrete, the good water permeability and not easy to be blocked by shotcrete, and high practical and cost-effective. Finally, the selected filamentous plastic drainage pipe(s) is wrapped with geotextile outside. For the scattered leakage water, firstly the drainage steel flower pipe(s) is set up at the water source (the specific method

is the same as the above section), and then the dendritic layout for the permeable blind pipes is adopted. The drainage blind pipe(s) is fixed on the shotcrete mesh with iron wire tightly twisted, so as to collect water and form a water channel. After installation, it is closed by the shotcrete, and an effective permeable channel is formed inside the shotcrete. The groundwater is drained into the base drainage ditch along with the permeable channel.

4. Foundation pit bottom drainage

The structure of the station base slab is in weathered mudstone, which has the characteristics of weak expandability, impermeability and high fissure water developed. Strong weathered mudstone is extremely soft. Under the action of groundwater, mudstone is easy to soften and collapse, and the embedded depth of foundation pit guard posts are greatly affected, which will cause foundation pit instability and collapse when seriously. Therefore, it is particularly important to deal with the drainage of side wall water and rainwater from the foundation pit in time, and to strengthen the protection of the mudstone structure of the basement.

A pathway drainage ditch and sump are set around the foundation pit at the bottom of the foundation pit. The drainage ditch and sump are filled with coarse-grained gravels, and then a sewage pump meeting the delivery lift is placed in the sump. The side wall leakage, rainwater, construction water and other wastewater are drained into the drainage system outside the foundation pit through sewage pump, and then discharged into the municipal pipe network after sedimentation in the sedimentation tank. The specific requirements are as follows:

(1) The basement drainage ditch is lower than the bottom surface of the foundation pit, with ditch width as 0.5 m, and depth as 0.5 m. The drainage ditch is set with a longitudinal slope of 0.3% for the water flowing to the nearby sump.

(2) The basement drainage ditch pathway is set up around the bottom of foundation pit, about 2.5 m away from the guard posts.

(3) When making the base slab cushion concrete, the ditch and ponding wells are tightly backfilled with coarse-grained stones and covered with waterproof roll. After the construction of the cushion, the drainage ditch at the base becomes a blind seepage ditch, and continues to be responsible for the collection of water from the side wall to drain out of the foundation pit. When the structure is completely closed, the basement drainage ditch loses its function.

During excavation in rainy season, the exposed surface of excavation is covered with colored strip cloth to prevent rainwater from penetrating into the soil layer, which will cause operation of earthwork with water. Rainwater is collected into the surrounding drainage ditch and the water reservoir well, and then pumped to the ground drainage system.

After the foundation pit is excavated to the bottom by section, the exposed surface of the bottom can be closed and sealed by spraying (plastering) 1:3 cement mortar or covering with plastic geomembrane.

Based on the actual construction example of Jincheng Avenue station of Chengdu Metro Line 9, the present invention studies two kinds of comprehensive dewatering and water control technologies for subway deep foundation pit with different permeable geology within the same scope of foundation pit, solves the cost waste caused by incomplete dewatering and eliminates the potential safety hazard of serious accident consequence caused by base soaking from incomplete water control, and also provides relevant construction experience for similar projects in the future.

CLAIMS

1. A new comprehensive dewatering and drainage method for mudstone subway station characterized in that, the said new comprehensive dewatering and drainage method for mudstone subway station comprises:

Step one, a station adopts well point dewatering firstly;

Step two, a foundation pit is excavated to beneath mudstone, and blind ducts are used to drain to beneath a bottom plate;

Step three, blind ditches are provided around the foundation pit bottom surface and the blind ducts are buried in the blind ditches, and the water flow is drained by the blind ditches from the side wall into a sump, which avoids the phenomenon of foundation pit mudstone being soaked by water and water ponding in the foundation pit, and achieves the dewatering and drainage.

2. The said new comprehensive dewatering and drainage method for mudstone subway station in claim 1, characterized in that, in Step one, the deep well pipe well dewatering is adopted in the well point dewatering, which specifically comprises:

the technology of making holes by auger drill is adopted in well holes, after a well pipe is hoisted and placed, filtration media is evenly placed along periphery of the well pipe, when the filtration media is filled below a wellhead, clay is filled to tamp and flat, the well is washed with air compressor and piston jointly, wherein using air compressor to wash well, and then using piston to wash well.

3. The said new comprehensive dewatering and drainage method for

mudstone subway station in claim 2, characterized in that, the upper part of the well pipe is composed of multiple sections of reinforced concrete pipes, and the lower part of the well pipe is composed of four sections of filter pipes and one section of grit pipe, the well pipe is 200 mm above the ground; the said filter pipe is reinforced concrete pipe full of water filtering holes on the surface, and the outside of the said reinforced concrete pipe is wrapped with wire mesh, dense mesh and sparse mesh sand filtering water-permeable layer.

4. The said new comprehensive dewatering and drainage method for mudstone subway station in claim 1, characterized in that, the said foundation pit adopts borehole piles with net sprayed concrete as the enclosing structure, water collecting ditches are arranged in the foundation pit, through which the water flow will flow into a water reservoir well, and then the water will be discharged to a ground drainage system around the foundation pit by mud pump, and discharged into a rainwater pipe after sedimentation.

5. The said new comprehensive dewatering and drainage method for mudstone subway station in claim 4, characterized in that, the water collecting ditches are lower than the bottom surface of the foundation pit, and are square open ditches, and longitudinal slopes are set at the bottom of the ditches, the water collecting ditches are set on both sides of the foundation pit; a shaft wall of the water reservoir well is reinforced with bamboo cage and wooden board, and the centrifugal pump is used to pump and remove from the well, when making bottom slab bedding concrete, the ditches and the ponding wells are densely backfilled with the bedding concrete, and then the bedding is constructed.

6. The said new comprehensive dewatering and drainage method for mudstone subway station in claim 5, characterized in that, during the rainy season excavation of the foundation pit, the longitudinal slope surface is covered with color striped waterproof cloth, and the rainwater is collected to the lowest point of water reservoir well, and open drained to the ground drainage system by water pump, the excavation by sections is adopted for the foundation pit, and stops when the foundation pit is excavated to 30 cm of the base.

7. The said new comprehensive dewatering and drainage method for mudstone subway station in claim 1, characterized by also comprising:

surface water interception and drainage, well point dewatering outside the foundation pit, open water drainage from the side wall of the foundation pit, drainage from the base drainage ditch and water reservoir well;

the said surface water interception and drainage comprises: surface water seal and setting of drainage, setting of surface water ditch;

the said well point dewatering outside the foundation pit comprises: construction procedures of dewatering wells, measuring and setting out well location, embedding opening protective pipe, installing drilling rig, forming hole, cleaning hole, installing casing pipes, filling filter material, well washing for dewatering well, installing water pump and testing pumping;

the said open water drainage from the side wall of the foundation pit comprises: strand-shaped crevice water guide and drainage at the interface between sand gravels and mudstone and mudstone, treatment of scattered crevice water in the side wall of the foundation pit;

the said drainage from the base drainage ditch and water reservoir well comprises: a pathway drainage ditch and sump is set around the foundation pit at the bottom of the foundation pit, and the drainage ditch and sump are

filled with coarse-grained gravels, and a sewage pump meeting the lift is placed in the sump, the side wall leakage, rainwater, construction water and other wastewater is drained into the drainage system outside the foundation pit through sewage pump, and then discharged into the municipal pipe network after sedimentation in the sedimentation tank.

8. A new comprehensive dewatering and drainage device for mudstone subway station by using the said new comprehensive dewatering and drainage method for mudstone subway station in any one of claims 1-7, characterized in that, the said comprehensive dewatering and drainage device for mudstone subway station has:

the foundation pit bottom surface;

wherein the said foundation pit bottom surface is provided with a blind ditch, and the horizontal blind ducts and the vertical blind ducts are embedded in the said blind ditch;

a water collecting ditch is arranged in the foundation pit, and the said water collecting ditch is connected with a water reservoir well.

Ansprüche

1. Neuartiges umfassendes Wasserabsenkungs- und Entwässerungsverfahren für Schlammstein-U-Bahn-Stationen, dadurch gekennzeichnet, dass das neuartige umfassende Wasserabsenkungs- und Entwässerungsverfahren für Schlammstein-U-Bahn-Stationen Folgendes umfasst:

Schritt 1: die Station nimmt zuerst Brunnenpunkte zur Wasserabsenkung an;

Schritt 2: Ausgraben der Gründungsgrube bis unter den Schlammstein, Verwenden eines Blindrohrs, um die Strömung bis unter die Bodenplatte zu führen;

Schritt 3: Anordnen blinder Gräben um die Bodenfläche der Gründungsgrube herum, Einbetten der Blindrohre in den blinden Gräben, Abführen des von der Seitenwand herausgeführten Wasserstroms durch die Blindrohre in die Wassersammelgrube, um zu vermeiden, dass der Schlammstein der Gründungsgrube im Wasser getränkt wird und Wasser sich in der Gründungsgrube ansammelt, wodurch eine Wasserabsenkung und Entwässerung realisiert werden.

2. Neuartiges umfassendes Wasserabsenkungs- und Entwässerungsverfahren für Schlammstein-U-Bahn-Stationen nach Anspruch 1, dadurch gekennzeichnet, dass im Schritt 1 die Wasserabsenkung der Brunnenpunkte eine Tiefbrunnenrohr-Wasserabsenkung annimmt, was insbesondere Folgendes umfasst:

Bilden eines Bohrlochs durch Rotationsbohren, nachdem das Brunnenrohr angehoben war, wird das Filtermaterial gleichmäßig um das Brunnenrohr herum gelegt, das Filtermaterial wird unter der Öffnung des Brunnens gefüllt und mit kohäsivem Boden fest zugestopft, unter gemeinsamer Verwendung des Luftkompressors und des Kolbens wird der Brunnen gewaschen, nach der Reinigung durch den Luftkompressor wird der Brunnen dann unter Verwendung des Kolbens gewaschen.

3. Neuartiges umfassendes Wasserabsenkungs- und Entwässerungsverfahren für Schlammstein-U-Bahn-Stationen nach Anspruch 2, dadurch gekennzeichnet, dass das Oberteil des Brunnenrohrs durch mehrere Abschnitte von Stahlbetonrohren gebildet ist, wobei das Unterteil durch 4 Abschnitte von Wasserfilterrohren und 1 Abschnitt von Sandabsetzrohr gebildet ist, und wobei das Brunnenrohr 200 mm über dem Boden liegt; und wobei das Wasserfilterrohr ein Stahlbetonrohr ist, dessen Oberfläche mit Wasserfilterlöchern versehen ist, und wobei die Außenseite des Stahlbetonrohrs mit einem Drahtgeflecht, einem dichten Netz und einer durchlässigen Schicht mit dünner Filtersand umhüllt ist.

4. Neuartiges umfassendes Wasserabsenkungs- und Entwässerungsverfahren für Schlammstein-U-Bahn-Stationen nach Anspruch 1, dadurch gekennzeichnet, dass die Gründungsgrube die gebohrten Pfähle und Hängenetz-Spritzbeton als Schutzstruktur annimmt, wobei in der Gründungsgrube ein Wassersammelgraben angeordnet ist, durch den der Wasserstrom in den Wassersammelbrunnen einfließt, und wobei dann mittels der Schlammpumpe das Wasser ins Bodenentwässerungssystem um die Gründungsgruben herum abgeführt und nach der Sedimentation in die Regenwasserleitung abgelassen wird.

5. Neuartiges umfassendes Wasserabsenkungs- und Entwässerungsverfahren für Schlammstein-U-Bahn-Stationen nach Anspruch 4, dadurch gekennzeichnet, dass der Wassersammelgraben niedriger als die Bodenfläche der Gründungsgrube ist und ein quadratischer offener Graben ist, wobei am Boden des Grabens eine Längsneigung angeordnet ist, und wobei der Wassersammelgraben auf den beiden Seiten der Gründungsgrube angeordnet ist; und wobei die Brunnenwand des Wassersammelbrunnens durch Bambuskäfige und Holzbretter verstärkt wird, und wobei eine Zentrifugalpumpe zum Absaugen und Abführen aus dem Brunnen verwendet wird, und wobei beim Herstellen des Betons der unteren Unterlegschicht der Wassergraben und der Wasserbrunnen mit dem Beton der unteren Unterlegschicht dicht verfüllt sind und dann die Unterlegschicht hergestellt wird.

6. Neuartiges umfassendes Wasserabsenkungs- und Entwässerungsverfahren für Schlammstein-U-Bahn-Stationen nach Anspruch 5, dadurch gekennzeichnet, dass beim Ausgraben der Gründungsgrube in der Regenzeit die Längsneigungsfläche mit farbig gestreiftem wasserdichtem Tuch abgedeckt ist, wobei das Regenwasser in dem Wassersammelbrunnen an der niedrigsten Stelle angesammelt und dann durch eine Wasserpumpe zu dem Bodenentwässerungssystem abgeführt wird, und wobei die Gründungsgrube abschnittsweise ausgegraben wird und die Ausgrabung bei einer Stelle mit einem Abstand von 30 cm zu dem Substrat gestoppt wird.

7. Neuartiges umfassendes Wasserabsenkungs- und Entwässerungsverfahren für Schlammstein-U-Bahn-Stationen nach Anspruch 1, dadurch gekennzeichnet,

Abfangen und Abführen von Oberflächenwasser, Wasserabsenkung des Brunnenpunkts außerhalb der Gründungsgrube, Abführen von offenem Wasser an der Seitenwand der Gründungsgrube, und Abführen durch den Entwässerungskanal und den Wassersammelbrunnen des Substrats;

wobei das Abfangen und Abführen von Oberflächenwasser umfassen: Anordnen der Bodenoberflächendichtung und Entwässerung sowie Anordnen des Oberflächenwassergrabens;

wobei die Wasserabsenkung des Brunnenpunkts außerhalb der Gründungsgrube umfasst: Konstruktionsprozess des Wasserabsenkungsbrunnens, Messen der Brunnenposition, Einbetten des Öffnungsschutzrohrs, Installieren der Bohrmaschine, Bilden des Lochs, Reinigen des Lochs, Installieren des Brunnenwandrohrs, Füllen des Filtermaterials, Waschen des Wasserabsenkungsbrunnens, Installieren und Probeziehen der Wasserpumpe;

wobei das Abführen von offenem Wasser an der Seitenwand der Gründungsgrube umfasst: Abführen vom Wasser an der Grenzfläche zwischen sandigem Kies und Schlammstein und Wasser des strangförmigen Spalts des Schlammsteins, Behandeln von Wasser des zerstreuten Spalts der Seitenwand der

Gründungsgrube;

wobei das Abführen durch den Entwässerungskanal und den Wassersammelbrunnen des Substrats umfasst: Anordnen eines Durchgangsentwässerungskanals und einer Wassersammelgrube um die Gründungsgrube herum an dem Boden der Gründungsgrube, wobei der Entwässerungskanal und die Wassersammelgrube mit grobkörnigem Kies verfüllt sind, und wobei in der Wassersammelgrube eine Abwasserpumpe, die die Anforderung an den Pumpenhub erfüllt, platziert ist, und wobei durch die Abwasserpumpe das Seitenwandleckwasser, das Regenwasser, das Bauwasser und das Abwasser durch die Abwasserpumpe in das Entwässerungssystem außerhalb der Gründungsgrube abgeführt und dann nach dem Absetzen durch den Sedimentationstank in das kommunale Rohrnetz abgelassen werden.

8. Neuartige umfassende Wasserabsenkungs- und Entwässerungsvorrichtung für Schlammstein-U-Bahn-Stationen, die ein neuartiges umfassendes Wasserabsenkungs- und Entwässerungsverfahren für Schlammstein-U-Bahn-Stationen nach einem der Ansprüche 1 bis 7 implementiert, dadurch gekennzeichnet, dass die umfassende Wasserabsenkungs- und Entwässerungsvorrichtung umfasst:

eine Bodenfläche der Gründungsgrube;

wobei an der Bodenfläche der Gründungsgrube ein blinder Graben angeordnet ist, in dem ein horizontales Blindrohr und ein vertikales Blindrohr eingebettet sind;

und wobei in der Gründungsgrube ein Wassersammelgraben angeordnet ist, der mit dem Wassersammelbrunnen verbunden ist.

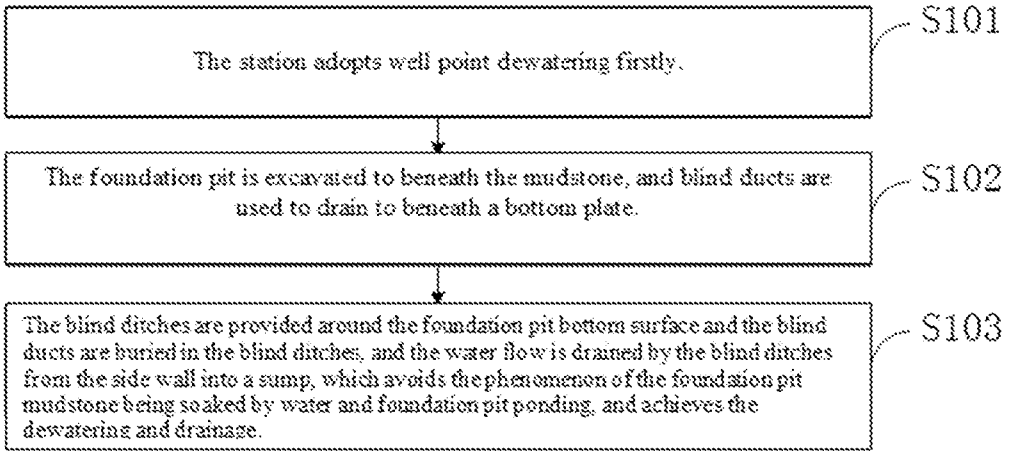
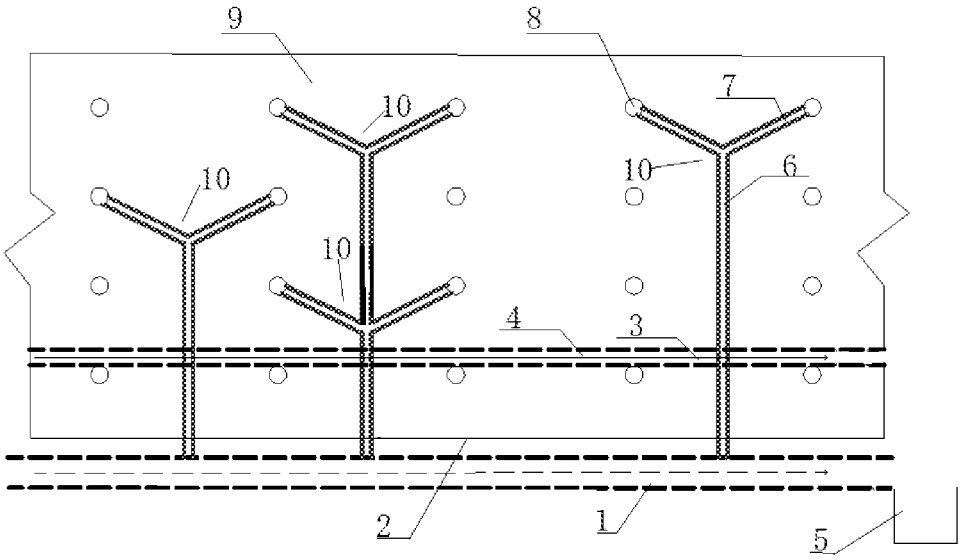

The station adopts well point dewatering firstly.
S101
The foundation pit is excavated to beneath the mudstone, and blind ducts are used to drain to beneath a bottom plate.
S102
The blind ditches are provided around the foundation pit bottom surface and the blind ducts are buried in the blind ditches, and the water flow is drained by the blind ditches from the side wall into a sump, which avoids the phenomenon of the foundation pit mudstone being soaked by water and foundation pit ponding, and achieves the dewatering and drainage.
S103

Fig.1


9
8
7
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5

Fig.2

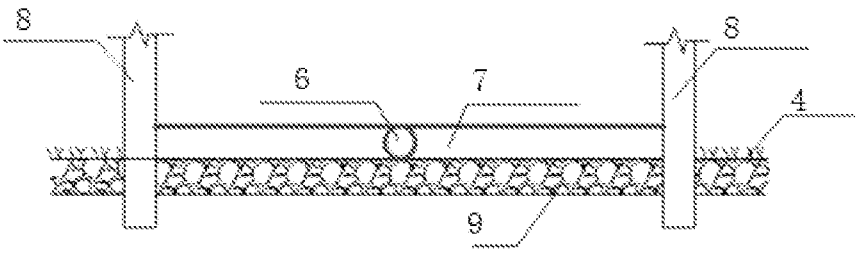
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Fig.3

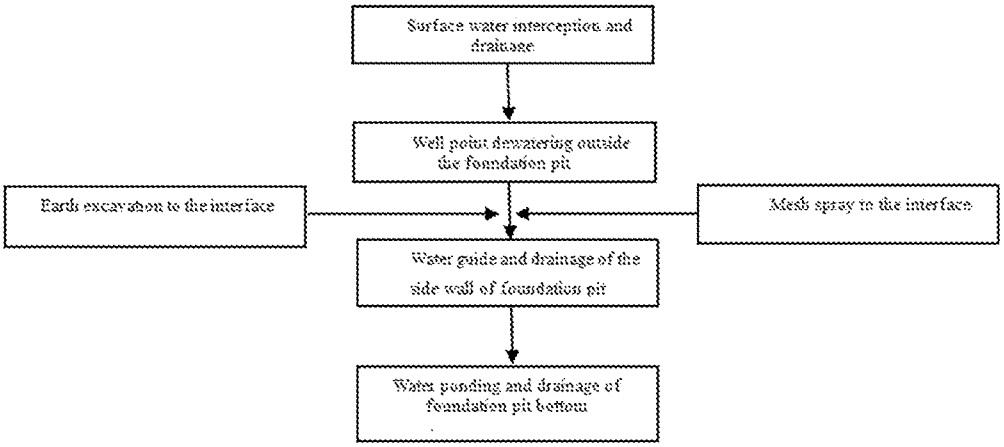

Fig.4

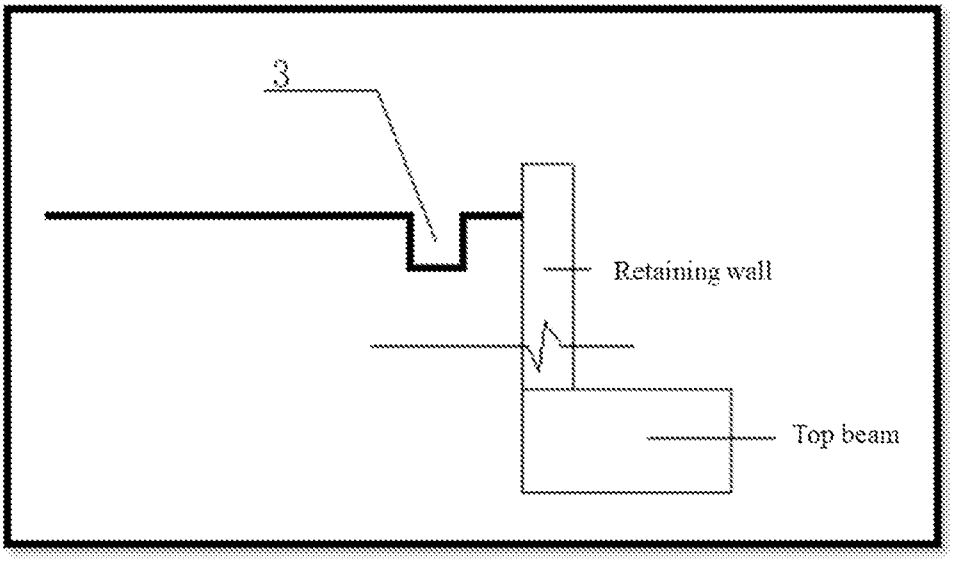

Fig.5

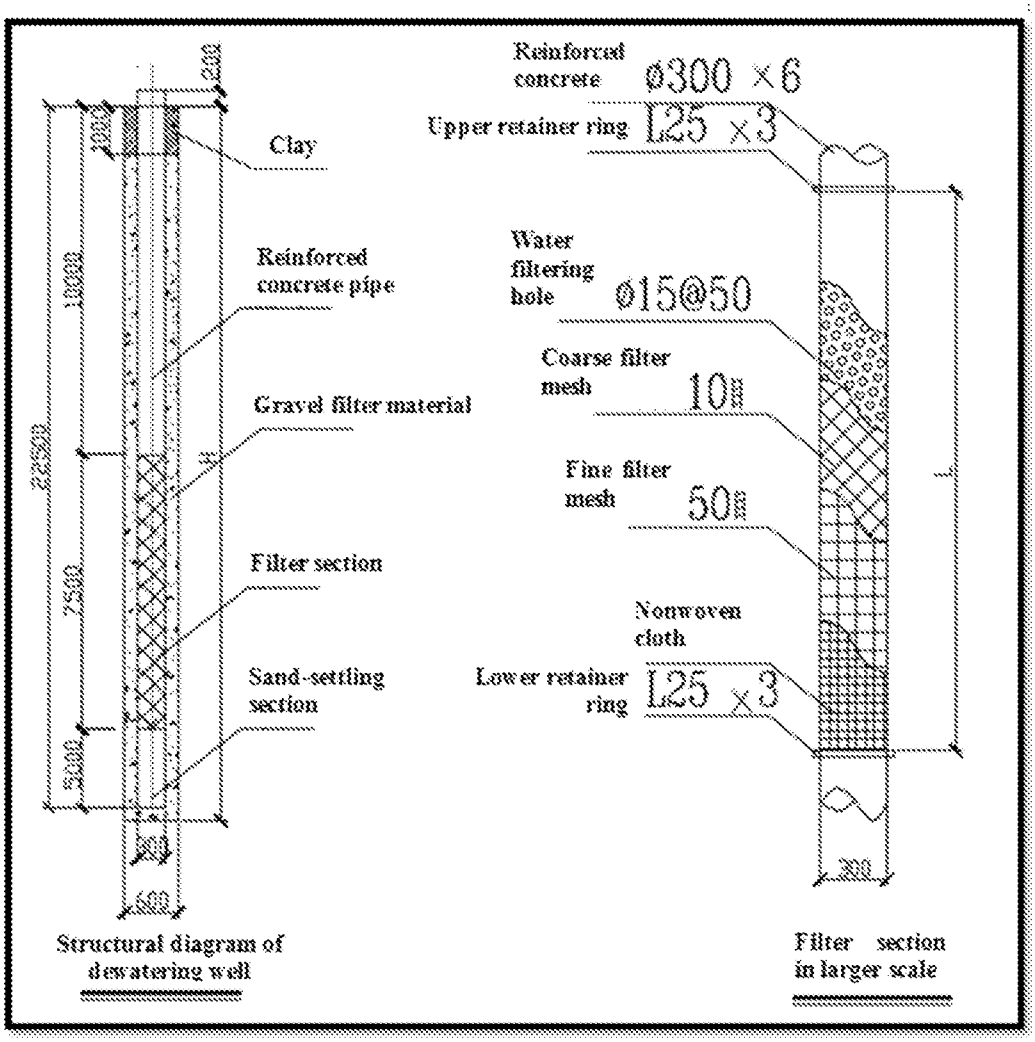
Reinforcat concrete
ø300 ×6
Upper retainer ring
L25 ×3
Clay
Reinforced concrete pipe
Water filtering hole
ø15@50
Coarse filter mesh
10
Gravel filter material
Fine filter mesh
50
Filter section
Nonwoven cloth
Sand-settling section
Lower retainer ring
L25 ×3
Structural diagram of dewatering well
Filter section in larger scale

Fig. 6

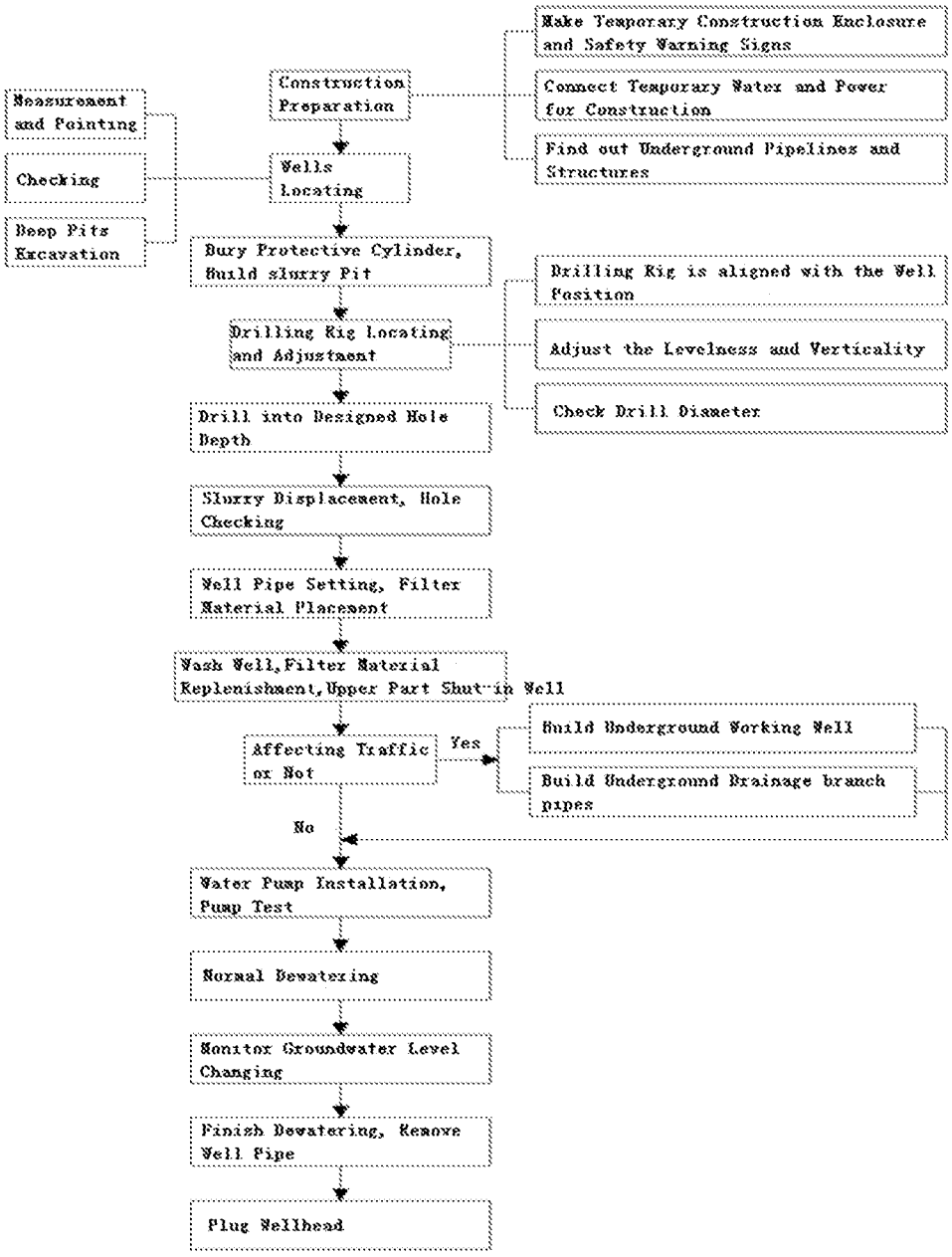
Make Temporary Construction Enclosure and Safety Warning Signs
Construction Preparation
Connect Temporary Water and Power for Construction
Find out Underground Pipelines and Structures
Measurement and Pointing
Checking
Wells Locating
Deep Pits Excavation
Bury Protective Cylinder, Build slurry Pit
Drilling Rig is aligned with the Well Position
Drilling Rig Locating and Adjustment
Adjust the Levelness and Verticality
Check Drill Diameter
Drill into Designed Hole Depth
Slurry Displacement, Hole Checking
Well Pipe Setting, Filter Material Placement
Wash Well, Filter Material Replenishment, Upper Part Shut-in Well
Affecting Traffic or Not
Yes
Build Underground Working Well
Build Underground Drainage branch pipes
No
Water Pump Installation, Pump Test
Normal Dewatering
Monitor Groundwater Level Changing
Finish Dewatering, Remove Well Pipe
Plug Wellhead

Fig. 7

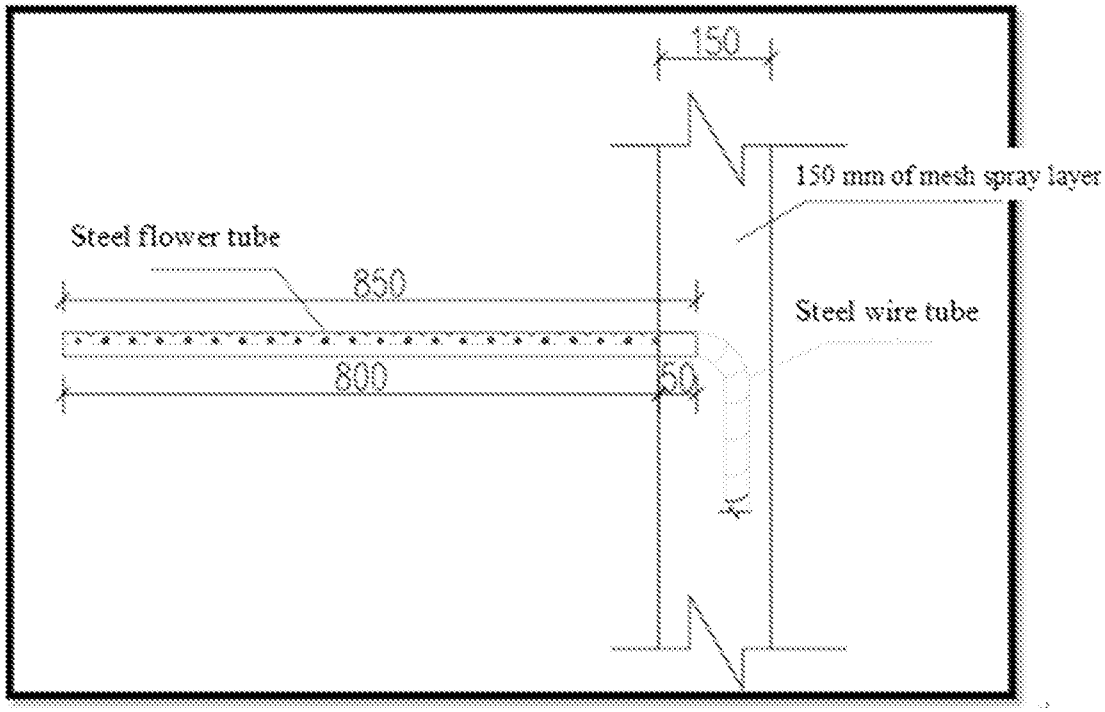
150
150 mm of mesh spray layer
Steel flower tube
850
Steel wire tube
800
50

Fig. 8