

[Document Name] Description

[Title of Invention] CONSTRUCTION METHOD OF UNDERGROUND
STRUCTURE

[Technical Field]

5 The present invention relates to a construction method of an underground structure, capable of implementing an underground structure having a greater width in a ground under a railroad, road, or the like in a direction traversing it, without bringing about the inconvenience to the upper traffic upon excavatingly advancing to construct the crossed underground structure.

10 [Background Art]

 In a field of railroad in Japan, the mainstream of a construction method of an underground structure crossed with a railroad thereon has been initially an open cut method, a temporary track method, or a method (grillage girder method) for temporarily supporting a rail track. However, it has become difficult to adopt
15 the open cut method accompanied by numerous operations on a rail track, due to the progressively increased number of train transits. This has led to a development of a non-open cut method as a method capable of constructing a structure under a rail track in a manner to be crossed therewith and in a state ensuring transits of trains. This method is basically configured to propel, by a
20 jack, a precast concrete box (box culvert) having a cutting edge attached thereto, by excavating a portion of a ground at the cutting edge from an inside of the box to thereby form a space in the ground.

 The applicant previously filed an application as shown in following patent literature.

25 It is therefore an object of the present invention to provide a construction method capable of constructing a structure in a ground by towing the structure made of a full-size precast concrete to thereby eliminate the inconvenience in case of the above-described conventional example, which construction method is extremely high in safety, which construction method never requires large-scale

facilities unlike a shield tunneling method, and which construction method never leaves a traversing site in an unstable state over a long period of time unlike an open cut method configured to form a large ditch in a ground while conducting an earth retainment in a manner to form a concrete structure by a mold in the ditch,
5 and unlike a cast-in-place concrete method based on a temporary support by a false-work, configured to construct the false-work and excavate a ground therein to thereby form a concrete structure.

[Patent literature]

SG PATENT APPLICAON

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The contents are indicated on figure 11 and figure12.

15 In the figure11, reference numeral 16 designates a pipe roof, and provision is made of a protecting work by such a pipe roof 16.

Designate precast concrete boxes (box culverts), respectively, each having a cutting edge 2 based on a steel-made hood attached to a front end of the concrete box, and these precast concrete boxes are installed at both sides of a
20 traversing site under an upper traffic 8 such as a rail track(s), respectively, such that towing directions of the precast concrete boxes are opposed to each other.

One of the concrete boxes 1 has a rear portion provided with towing jacks
10 attached thereto, and the other concrete box 1 has a rear portion provided with fixing members 11 attached thereto, in a manner that PC wires 12 to be
25 utilized as towing members are penetrated through the traversing site, and ends of each PC wire 12 are fixed to the associated towing jack 10 and fixing member 11, respectively.

Meanwhile, as shown in FIG. 13and FIG. 14, guiding pilot tunnels 18 are provided by excavation, at positions where corner portions of a bottom

floor plate of the concrete box 1 are located, respectively. Examples of the guiding pilot tunnel 18 include various types, and the example of FIG. 5 shows a case of arch type tunnel configured to conduct earth retainment by lining up H-shaped steels or liner plates 19 next to each other as a false-work, while conducting excavation.

In FIG. 13 and FIG. 14, reference numeral 25 designates a guiding H-shaped steel, and reference numeral 26 designates a guide rail.

The above-mentioned uncoated stress relieved PC wires 12 is something to install in the upper and lower second dan, and uncoated stress-relieved PC wires 12 in the upper row bores a horizontal drilling hole in the crossing part, and later, the uncoated stress relieved PC wires 12 which will be a lower berth later will let inside the concrete box 1 through the guiding pilot tunnel 18 inside of a mine through this inside.

Each towing jack 10 is a center hole jack as shown in FIG. 15, and each fixing member 11 comprises a fixing block 11a, and wedges 11b each of a split pin type in a wedge shape to be pushed into each hole of the fixing block 11a as shown in FIG. 16. Each wedge 11b is pushed into the associated hole of the fixing block 11a while penetrating one of twisted threads constituting the PC wire 12 through the wedge 11b itself, thereby fastening the applicable PC wire 12 to the associated fixing member 11 by virtue of a wedge effect.

Also, in case of fixing each PC wire 12 to the associated towing jack 10, that portion of the PC wire 12, which is penetrated through the towing jack 10 and exposed, is fastened thereto by attaching another fixing member 11 to that portion.

In this way, the towing jacks 10 are used to mutually tow concrete boxes 1 to be constructed at both sides of the traversing site, in a box-by-box manner utilizing the cooperating one of the boxes as a reactive resistance body.

The concrete box 1, which acts as the reactive resistance body, is that before conduction of such excavation. The excavation is conducted by using an

excavator, or by a human power, as the case may be.

In case of towing each concrete box 1, excavation of a portion of a ground at the cutting edge 2 is conducted from an inside of the cutting edge to thereby form a space in the soil and sand in front of it, and the concrete box 1 is
5 correspondingly advanced by an excavated distance.

The concrete box 1, which acts as the reactive resistance body, is that before conduction of such excavation. The excavation is conducted by using an excavator, or by a human power, as the case may be.

In this figure, reference numerals 7 designate foundation concretes, and
10 reference numeral 8 designates an upper traffic such as a rail track. Further, reference numerals 13 each designate an earth retaining member for forming a starting vertical shaft 3 or arrival vertical shaft 9, and the earth retaining member is facing cut to form an opening into which the applicable concrete box 1 is penetrated.

15 Further, reference numerals 5, 6, and 7 designate a reaction wall provided with a starting vertical shaft 3, a strut, and a foundation concrete, respectively.

Shown in FIG. 14 is a finally docked state. In this case, starting vertical shafts 3 are provided on both sides of the underground structure, respectively, to
20 establish an implementing section A therebetween.

In turn, FIG.10 shows an embodiment configured to install a reactive body at a side of arrival vertical shaft 9, to install a concrete box 1 provided with a rear portion having towing jacks 10 attached thereto at a side of starting vertical shaft 3, and to penetrate PC wires 12 as towing members through a
25 traversing portion, in a manner to fix ends of each PC wire 12 to the associated towing jack 10 and the associated fixing member 11 provided on the reactive body, respectively.

In this embodiment, the reactive body placed at the side of arrival vertical shaft 9 is constituted of a reactive box 14. This reactive box 14 has a reactive

resistance enhancing key 14a.

The concrete box 1 is towed by the PC wires 12 from the side of starting vertical shaft 3 toward the arrival side, by using the reactive box 14 as an anchor.

It is noted that, as a technique to obtain a reactive force in the one-side towing method shown in FIG. 2, it is also possible to obtain a reactive force in a way different from the reactive box 14, in an exemplary manner to directly obtain a reactive force from a natural ground at the backside, to provide a retaining wall to obtain a reactive force therefrom, or to form an embankment to obtain a reactive force therefrom.

10 [Summary of the Invention]

[Problems to be Solved by Invention]

When the geology of the cross section is rock formations, the pipe roof built as protecting work will be something with the big caliber because horizontal drilling building of a micro bore is difficult when the geological feature of the crossing part is the terrane.

So even if a pipe roof with a large caliber is installed as a protection work, there is a fear that a pipe roof moves by the frictional force on the top surface of the case at the time of towing the case (between the upper ground and the concrete box top).

20 The purpose of this invention was accomplished to settle the conventional problem that a construction method capable of an underground structure, when the geology of the cross section is rock formations, it is difficult to perform horizontal boring with a small caliber, so even if a pipe roof with a large caliber is installed as a protection work, the frictional force on the top surface of the case at the time of towing the case (between the upper ground and the concrete box top), the movement of the pipe roof can be suppressed.

[Means for Solving the Problems]

To achieve the above object, the scope of the invention recited in Claim 1

resides in a construction method of an underground structure, comprising the steps of:

Installing precast concrete boxes each having a cutting edge based on a steel-made hood attached to a front end of the concrete box, at both sides of a traversing site, respectively, such that towing directions of the precast concrete boxes are opposed to each other; attaching a towing jack to a rear portion of one of the precast concrete boxes, attaching a fixing member to a rear portion of the other, and penetrating a PC wire as a towing member through the traversing portion in a manner to fix ends of the PC wire to the towing jack and the fixing member, respectively; and using the towing jack to mutually tow the precast concrete boxes in a box-by-box manner utilizing the cooperating one of the precast concrete boxes as a reactive resistance body, prior to towing of the concrete box, pipe roof is constructed in an upper portion, frame is installed in the tag end of concrete box so that even overhang on this concrete box, the above-mentioned frame is connected mutually by the towing member inserted in the above-mentioned pipe roof, the front side of concrete box is excavated as well as, using the towing jack installed in the edge of the towing member the precast concrete box toward in the underground structure building ground.

According to this invention of Claim 1, because a frame was installed so that it might protrude to the way on the concrete box in the end behind the concrete box, so a tow part can let in the pipe roof through by this, and as a result, the frictional force on the top surface of the case at the time of towing the case(between the upper ground and the concrete box top),the movement of the pipe roof can be suppressed.

The scope of the invention recited in Claim 2 resides in a construction method of an underground structure, comprising the steps of: installing a reactive body at a side of an arrival vertical shaft, and installing a precast concrete box having a rear portion provided with a towing jack at a side of a

starting vertical shaft; penetrating a PC wire as a towing member through a traversing portion, and fixing ends of the PC wire to the towing jack and a fixing member provided on the reactive body; and using the towing jack to tow the precast concrete box from the side of the starting vertical shaft toward the side of the arrival vertical shaft by the PC wire, by using the reactive body as an anchor, prior to towing of the concrete box, pipe roof is constructed in an upper portion, frame is installed in the tag end of concrete box so that even overhang on this concrete box, the above-mentioned frame is connected installing a reactive body at a side of an arrival vertical shaft by the towing member inserted in the above-mentioned pipe roof, the front side of concrete box is excavated as well as, using the towing jack installed in the edge of the towing member the precast concrete box toward in the underground structure building ground.

Like this invention which is Claim 1 ,according to this invention of Claim 2, because a frame was installed so that it might protrude to the way on the concrete box in the end behind the concrete box, so a tow part can let in the pipe roof through by this, and as a result, the frictional force on the top surface of the case at the time of towing the case(between the upper ground and the concrete box top),the movement of the pipe roof can be suppressed.

[Advantage Effect of the Invention]

implementing a box type roof, as a protecting work, comprising juxtaposed roof-aimed tubes made of rectangular steel pipes, prior to the towing of the concrete box; and sequentially advancing the roof-aimed tubes.

As described above, the construction method of an underground structure of the present invention is capable of constructing a structure in a ground by towing the structure made of a full-size precast concrete, such as in case of excavatingly advancing to construct an underground structure having a greater

width in a ground under a railroad, road, or the like in a direction traversing it, which construction method is extremely high in safety, which construction method never requires large-scale facilities unlike a shield tunneling method, and which construction method never leaves a traversing site in an unstable
5 state over a long period of time unlike an open cut method configured to form a large ditch in a ground while conducting an earth retainment in a manner to form a concrete structure by a mold in the ditch, and unlike a cast-in-place concrete method based on a temporary support by a false-work, configured to construct the false-work and excavate a ground therein to thereby form a
10 concrete structure.

Moreover, when the geology of the cross section is rock formations, it is difficult to perform horizontal boring with a small caliber, so even if a pipe roof with a large caliber is installed as a protection work, the frictional force on the top surface of the case at the time of towing the
15 case(between the upper ground and the concrete box top), the movement of the pipe roof can be suppressed.

図面の簡単な説明

[Brief Description of the Drawings]

[Figure 1] Figure 1 is the side view which indicates the 1st process of
20 the 1st implementation form of the building method of construction of a structure in the ground of this invention.

[Figure 2] Figure 2 is the side view which indicates the 2nd process of the 1st implementation form of the building method of construction of a structure in the ground of this invention.

25 [Figure 3] Figure 3 is the side view which indicates the 3rd process of the 1st implementation form of the building method of construction of a structure in the ground of this invention.

[Figure 4] Figure 4 is the side view which indicates the 4th process of the 1st implementation form of the building method of

construction of a structure in the ground of this invention.

[Figure 5] Figure 5 is the side view which indicates the 5th process of the 1st implementation form of the building method of construction of a structure in the ground of this invention.

5 [Figure 6] Figure 6 is the side view which indicates the 6th process of the 1st implementation form of the building method of construction of a structure in the ground of this invention.

[Figure 7] Figure 7 is the side view which indicates the 7th process of the 1st implementation form of the building method of
10 construction of a structure in the ground of this invention.

[Figure 8] Figure 8 is the side view which indicates the 8th process of the 1st implementation form of the building method of construction of a structure in the ground of this invention.

[Figure 9] Figure 9 is the illustration which indicates
15 establishment of a pipe roof.

[Figure 10] Figure 10 is the side view which indicates the 2nd process of a building method of construction of a structure in the ground of this invention.

[Figure 11] FIG. 11 is a side view of an underground structure as a
20 conventional example.

[Figure 12] Figure 12 is a side view of an underground structure as a conventional example the other past.

[Figure 13] FIG. 13 is a front view of a guiding pilot tunnel of a mountain tunnel type.

25 [Figure 14] FIG.14 is a front view of a combination of a pipe-roof protecting work and guiding pilot tunnels.

[Figure 15] FIG. 15 is an explanatory view of a towing jack.

[Figure 16] FIG. 16 is an explanatory view of a fixing member.

[Figure 17] FIG. 17 is a side view of an underground structure in a

finally docked state as a conventional example;

[Description of Embodiments]

Preferred embodiments of the present invention will be described hereinafter in detail with reference to the accompanying drawings. Figure 1 is the side view which indicates the 1st process of the 1st implementation form of the building method of construction of a structure in the ground of this invention and figure 2 to figure 8 is the side view which indicates the 2nd to the 8th process of the 1st implementation form of the building method of construction of a structure in the ground of this invention.

In this case, earth retaining members 13 such as steel pile planks are hammer-set at both sides of both sides of the downward crossing part of upper part traffic 8 where it's for a railroad track such as a railroad to thereby construct the starting vertical shaft 3,

21 in the figure is reaction force pile installed in one start shaft 3, and 22 is temporary soil retaining pile.

And chemical grouting 23 is given to the ground between 3 fellows of start shaft.

Base concrete 7 is constructed in a bottom of two start shaft 3 in left and right as shown in figure 2, promotion stand 27 is assembled into start shaft 3 on the side where reaction force pile 21 was installed a propulsion device 28 is installed on it, and makes them promote so that pipe roof 16 may be pierced for other start shaft 3 by this propulsion device 28.

the pipe roof 16 is required to provide a protecting work for supporting an upper traffic, the pipe roof 16 is constructed by continuously arranging steel pipes so as to enclose, as a gate-shaped frame, the upper and lateral sides of the concrete box 1 having a rectangular cross section as shown in FIG. 9, and the concrete box 1 is caused to be inserted through the frame formed by the pipe roof 16 while leaving a spacing of a few tens of centimeters therebetween.

Pipe roof 16 is connected by coupler 16a of the C letter form

mutually by this implementation form. (There is sometimes no these coupler 16a.)

30 in the figure is the reaction force material installed in reaction force pile 21 and temporary soil retaining pile 22, and 29 is receipt of the
5 roof.

As shown in figure 4, reference numerals 1 designate precast concrete boxes (box culverts), respectively, each having a cutting edge 2 based on a steel-made hood attached to a front end of the concrete box, and these precast concrete boxes are installed at both sides of a traversing site under an upper traffic 8 such
10 as a rail track(s), respectively, such that towing directions of the precast concrete boxes are opposed to each other.

Hole 4 by horizontal drilling is given to the ground between start shaft 3 and start shaft 3.

Above-mentioned receipt of the roof 29 is changed for pipe roof
15 hanging protecting work 31.

As shown in FIG. 5, a frame(back frame) is installed in the tag end of concrete box so that even overhang on this concrete box , towing jacks
10 are installed in frame 5 of this one concrete box, and fixing member 11 is installed in frame 5 of the other concrete box, and PC wires 12 as towing
20 members as a tow part is inserted in pipe roof 16, and the end of this PC wires 12 as towing members settles in towing jacks 10 and fixing member 11.

Towing jacks 10 are installed in frame 5 of one concrete box at the lower part, and fixing member 11 is installed in frame 5 of the other concrete box, and PC wires 12 as towing members as a tow part is shown
25 into the bowels of concrete box 1 and hole 4 by the above-mentioned horizontal drilling, and the end of this PC wires 12 settles in towing jacks 10 and fixing member 11.

Further reaction wall 6 is provided in the cutting edge 2 of one concrete box 1, and more first pipe roof stopper 15 is installed in the end

of pipe roof 16.

As shown in FIG. 6, the towing jacks 10 are used to mutually tow concrete boxes 1 to be constructed at both sides of the traversing site, in a box-by-box manner utilizing the cooperating one of the boxes as a reactive resistance body.

5 In case of towing each concrete box 1, excavation of a portion of a ground at the cutting edge 2 is conducted from an inside of the cutting edge to thereby form a space in the soil and sand in front of it, and the concrete box 1 is correspondingly advanced by an excavated distance. The concrete box 1, which acts as the reactive resistance body, is that before conduction of such excavation.

10 The excavation is conducted by using an excavator, or by a human power, as the case may be.

 An advance of this concrete box 1 makes one concrete box 1 (in a drawing, the left side) move ahead by the example indicated by a drawing, and makes one other concrete box 1 (in a drawing, the right
15 side) move ahead at the stage which has ended.

 In the case where one of the concrete boxes 1 (the left side in the drawing) is advanced, since the PC steel wire 12 as a towing member is passed through the pipe roof 16, furthermore, since the end of the PC steel wire 12 is pressed by the primary pipe roof stopper 15, as a result,
20 it is possible to suppress the movement of the pipe roof due to the box top frictional force (between the upper ground and the box top end) at the time of box towing.

 In that case, the first pipe roof stopper 14 is installed at the end of the pipe roof 16 on the upper surface of the concrete box 1 where the
25 advancement has been completed. Also, the blade inner reaction wall 6 and the first pipe roof stopper 15 of the concrete box 1 to be advanced are removed.

 In the case where the other concrete box 1 (the right side in the drawing) can be advanced, in that case, since the PC steel wire 12 as a

towing member is passed through the pipe roof 16, furthermore, since the end of the PC steel wire 12 is pressed by the primary pipe roof stopper 15, as a result, it is possible to suppress the movement of the pipe roof due to the box top frictional force (between the upper ground and the box top end) at the time of box towing.

Figure 8 shows the final docked state.

When the concrete boxes 1 reach each other, remove the cutting edge 2 etc, close the gap with the box hitting box 17, apply waterproof joints 20 and complete the construction.

Fig. 2 shows the case of the one-side towing method.

Fig. 2 shows an embodiment configured to install a reactive body at a side of arrival vertical shaft 9, to install a concrete box 1 provided with a rear portion having towing jacks 10 attached thereto at a side of starting vertical shaft 3, and to penetrate PC wires 12 as towing members through a traversing portion, in a manner to fix ends of each PC wire 12 to the associated towing jack 10 and the associated fixing member 11 provided on the reactive body, respectively.

In this embodiment, the reactive body placed at the side of arrival vertical shaft 9 is constituted of a reactive box 14. This reactive box 14 has a reactive resistance enhancing key 14a.

The concrete box 1 is towed by the PC wires 12 from the side of starting vertical shaft 3 toward the arrival side, by using the reactive box 14 as an anchor.

It is noted that, as a technique to obtain a reactive force in the one-side towing method shown in FIG. 2, it is also possible to obtain a reactive force in a way different from the reactive box 14, in an exemplary manner to directly obtain a reactive force from a natural ground at the backside, to provide a retaining wall to obtain a reactive force therefrom, or to form an embankment to obtain a reactive force therefrom.

Also in this case, a frame(back frame) is installed in the tag end of concrete box so that even overhang on this concrete box ,towing jacks 10

are installed in frame 5 of this one concrete box, and fixing member 11 is installed in frame 5 of the other concrete box, and PC wires 12 as towing members as a tow part is inserted in pipe roof 16, and the end of this PC wires 12 as towing members settles in towing jacks 10 and fixing member 5 11.

When advancing the concrete box 1, in that case, since the PC steel wire 12 as a towing member is passed through the pipe roof 16, furthermore, since the end of the PC steel wire 12 is pressed by the primary pipe roof stopper 15, as a result, it is possible to suppress the 10 movement of the pipe roof due to the box top frictional force (between the upper ground and the box top end) at the time of box towing.

[Document Name] Claims

[Claim 1]

A construction method of an underground structure, comprising the steps of:

5 installing precast concrete boxes each having a cutting edge based on a steel-made hood attached to a front end of the concrete box, at both sides of a traversing site, respectively, such that towing directions of the precast concrete boxes are opposed to each other;

10 attaching a towing jack to a rear portion of one of the precast concrete boxes, attaching a fixing member to a rear portion of the other, and penetrating a prestressed concrete (PC) wire as a towing member through the traversing portion in a manner to fix ends of the PC wire to the towing jack and the fixing member, respectively;

15 and using the towing jack to mutually tow the precast concrete boxes in a box-by-box manner utilizing the cooperating one of the precast concrete boxes as a reactive resistance body,

prior to towing of the concrete box, pipe roof is constructed in an upper portion,

20 a pipe roof stopper is installed in one end of the pipe roof, the PC wire being pressed by the pipe roof stopper,

frame is installed in the tag end of concrete box so that even overhang on this concrete box,

25 the above-mentioned frame is connected mutually by the towing member inserted in the above-mentioned pipe roof, the front side of concrete box is excavated, using the towing jack attached both to the frame of the precast concrete box and to the PC wire, the precast concrete box is towed toward the other precast concrete box in the underground structure building ground.

[Claim 2]

A construction method of an underground structure, comprising the steps of:

installing a reactive body at a side of an arrival vertical shaft, and installing
5 a precast concrete box having a rear portion provided with a towing jack at a side of a starting vertical shaft;

penetrating a prestressed concrete (PC) wire as a towing member through a traversing portion, and fixing ends of the PC wire to the towing jack and a fixing member provided on the reactive body;

and using the towing jack to tow the precast concrete box from the side of the starting vertical shaft toward the side of the arrival vertical shaft by the PC wire, by using the reactive body as an anchor,

5 prior to towing of the concrete box, pipe roof is constructed in an upper portion,

a pipe roof stopper is installed in one end of the pipe roof, the PC wire being pressed by the pipe roof stopper,

frame is installed in the tag end of concrete box so that even overhang on this concrete box,

10 the above-mentioned frame is connected installing a reactive body at a side of an arrival vertical shaft by the towing member inserted in the above-mentioned pipe roof, the front side of concrete box is excavated, using the towing jack attached both to the frame of the precast concrete box and to the PC wire, the precast concrete box is towed toward the reactive body in the underground
15 structure building ground.