

DESCRIPTION

Title of Invention

CONSTRUCTION METHOD FOR LARGE UNDERGROUND SPACE AND OUTER
5 SHELL SHIELD LUNCHING BASE

Technical Field

[0001]

The present invention relates to a construction method for the large underground space and outer shell Shield lunching base.

10 Priority is claimed on Japanese Patent Application No. 2016-051383, filed on March 15, 2016, the content of which is incorporated herein by reference.

Background Art

[0002]

15 In the related art, in a large cross-section road tunnel, a large underground space is built in a tunnel branch confluence part of a main shield tunnel and a ramp shield tunnel which are formed from a permanent shield tunnel. As a large underground space constructing method, for example, as disclosed in Patent Document 1, the following method is known. When construction work is carried out for an underground cavity so
20 as to form the large underground space by excavating ground, the construction work is carried out in an outer section at a planned excavated point of the underground cavity, in a state where a plurality of roof shield tunnels are arranged in advance with a predetermined interval. In this manner, a shield roof pre-supporting system is built so that the planned excavated point is surrounded by the roof shield tunnels.

25 [0003]

In addition, Patent Document 1 discloses the following construction method.

When the underground space is constructed, a plurality of outer shell shield tunnels are constructed in the outer section of the planned excavated point of the underground space, thereby building the shield roof pre-supporting system so as to surround the planned
 5 excavated point. According to the construction method, in the plurality of outer shell shield tunnels, an outer shell shield machine starts to carry out underground work by using a launching base under the ground installed in advance along an outer circumference of a previously installed tunnel.

Then, it is disclosed in Patent Document 2 that a circumference shield tunnel is
 10 used as the launching base under the ground of this outer shell shield machine. In Patent Document 2, construction work is carried out for a circumference shield tunnel having a rectangular section extending along a circumferential direction, in which a direction parallel to a tunnel central axis of the previously installed tunnel serves as a central axis of the circumference shield tunnel. The circumference shield tunnel is used
 15 as the launching base under the ground.

Citation List

Patent Literature

[0004]

20 [Patent Document 1] Japanese Patent No. 4958035

[Patent Document 2] Japanese Unexamined Patent Application, First
 Publication No. 2014-43738

Summary of Invention

25 Technical Problem

[0005]

However, according to the large underground space constructing method in the related art, problems arise as follows.

That is, in the launching base under the ground for starting the outer shell shield machine, it is difficult to cause a shield excavator having a rectangular section to carry out boring work for the launching base under the ground in a circumferential direction. Consequently, there is a possibility of increasing cost.

In addition, the constructed launching base under the ground has the rectangular cross section. Consequently, the launching base under the ground is structurally unstable against an external force applied by earth-water pressure received from a surrounding area thereof. In this regard, there is room for improvement.

[0006]

Incidentally, in a case where the plurality of outer shell shield tunnels are constructed by starting the outer shell shield machine from the previously installed ramp shield tunnel before a main shield machine passes in order to excavate the main shield tunnel (before the main shield tunnel is completed), it is necessary to construct a large diameter ring-shaped launching base for outer shell shield for integrally surrounding both the uncompleted main shield tunnel and the previously installed ramp shield tunnel.

As described above, Patent Document 2 above discloses the following method.

In order to construct the plurality of outer shell shield tunnels earlier around the outer section of the tunnel branch confluence part of the road tunnel, from a circumference shield starting base obtained by partially cutting and widening the main shield tunnel, a circumference shield machine starts to carry out excavation work in a circumferential direction along an outer circumferential surface of the main shield tunnel, thereby constructing the ring-shaped launching base for outer shell shield. Therefore, if there is

no change, the method disclosed in Patent Document 1 is less likely to be applied to the method of constructing the outer shell shield tunnel from the above-described ramp shield tunnel.

[0007]

5 In addition, the starting base requires a depth to a certain degree. Thus, from a viewpoint of effectively using the space, as the large diameter ring-shaped launching base for outer shell shield, it is desirable to provide the launching base for outer shell shield with the rectangular cross section. However, the rectangular shield is structurally unstable against the external force applied by the earth-water pressure received from the surrounding area, thereby causing a problem of difficult construction work. The construction work for a circular section shield is easily carried out, and is structurally stable. However, in a case where the construction work is carried out for the circular shield having a required diameter, an unnecessarily large space is left above and below the outer shell shield machine.

15 Furthermore, when the large diameter ring-shaped launching base for outer shell shield is constructed using the circumference shield machine, it is necessary to construct the circumference shield starting base so as to start the circumference shield machine. However, the circumference shield starting base is less likely to be constructed from a ground level since the required construction site is limited. Even if the construction can be carried out from the ground level, it is necessary to excavate a very deep pit from the ground level, thereby causing a possibility that the construction work may increase to a large scale. Therefore, in a case where the outer shell shield tunnel is constructed from the ramp shield tunnel, it has been required to construct the circumference shield starting base having a reasonable and compact structure which can be constructed using a non-open cut method.

20

25

[0008]

The present invention is made in view of the above-described circumstances, and an object thereof is to provide a large underground space constructing method and a launching base for outer shell shield, which can suppress an increase in scale, and which
5 enables a contractor to construct a low cost, structurally stable, compact, and reasonable structure for a launching base under the ground.

Solution to Problem

[0009]

10 In order to achieve the object by solving the above-described problems, the present invention adopts the following aspects.

(1) According to an aspect of the present invention, there is provided a large underground space constructing method in which when an enlarged tunnel part forming a tunnel branch confluence part of two permanent shield tunnels is constructed by
15 excavating ground, construction work is carried out in an outer section at a planned excavated point of the enlarged tunnel part in a state where a plurality of outer shell shield tunnels are arranged in advance in a tunnel circumferential direction so as to build an outer shell lining body for surrounding the planned excavated point with the outer shell shield tunnels, and so as to excavate an inner section of the outer shell lining body.

20 The construction method includes a construction process of simultaneously constructing a plurality of circular section circumference shield tunnels with an interval therebetween, along a circumferential direction in which a direction parallel to a tunnel axial direction of any one of the permanent shield tunnels serves as a central axis of the circumference shield tunnel, around the two permanent shield tunnels, a construction process of
25 constructing a plurality of adit tunnels for connecting the adjacent circumference shield

tunnels to each other along the circumferential direction with the interval therebetween, and a construction process of boring the plurality of outer shell shield tunnels by using the plurality of circumference shield tunnels and the plurality of adit tunnels as a launching base under the ground.

5 [0010]

In this case, when the outer shell lining body is built by the plurality of outer shell shield tunnels, a portion formed by connecting the plurality of circular section circumference shield tunnels extending along the circumferential direction to each other using the plurality of adit tunnels can be used as the launching base under the ground of
10 the outer shell shield tunnel. The circumference shield tunnel can be bored along the circumferential direction by a general circular section shield excavator. In addition, a required space can be secured as the starting base of the outer shell shield tunnel by excavating and connecting the circumference shield tunnels to each other in the horizontal direction. Therefore, compared to a case of using the rectangular section
15 shield excavator in the related art, the construction work is simply carried out, and thus, it is possible to achieve a reduced cost.

In addition, in this case, the circumference shield tunnel has a circular section which is structurally stable, and is structurally and advantageously resistant against the earth-water pressure of the ground. For example, compared to the rectangular section,
20 the thickness of segments can be minimized, and thus, the cost can be reduced.

[0011]

(2) The large underground space constructing method according to (1) described above may further include a construction process of forming a ground improvement zone around a portion of any one permanent shield tunnel between the two permanent shield
25 tunnels, and a construction process of building a launching shaft for shields

circumferential shield for starting work of the circumference shield tunnel in the ground improvement zone.

[0012]

In this case, the launching shaft for shields circumferential shield is built by
5 using one of the permanent shield tunnels, and the circumference shield machine is
caused to bore the circumference shield tunnel from the launching shaft for shields
circumferential shield in the circumferential direction. In this manner, the
circumference shield tunnel can be installed. Therefore, it is not necessary to carry out
large scale construction work which has to be carried out by excavating a pit from the
10 ground level for the launching shaft for shields circumferential shield. The construction
is not subject to constraints on ground land. Therefore, it is possible to achieve a
reduced construction cost and a reduced construction period.

[0013]

(3) In the large underground space constructing method according to (1) or (2)
15 described above, after the plurality of adit tunnels are installed by simultaneously
constructing the two circumference shield tunnels, one of the circumference shield
tunnels may be used as a launching shaft for outer shell shield, and the other one of the
circumference shield tunnels may be used as a material delivery adit.

[0014]

20 In this case, the start pit and the material delivery adit are independently
installed, and are connected to each other using the adit tunnel. In this manner, mutual
work sites are less affected by each other. It is possible to configure the starting base of
the outer shell shield tunnel in which the amount of unnecessary space is minimized.
Therefore, it is possible to achieve efficient construction work and a reduced cost.

25 [0015]

(4) The large underground space constructing method according to any one of (1) to (3) described above may further include a construction process of forming the outer shell lining body by connecting the plurality of outer shell shield tunnels to each other in the circumferential direction, a construction process of installing a first end wall in an inner section surrounded by the circumference shield tunnels, a construction process of installing a second end wall in an arrival point of the circumference shield tunnels, and a construction process of excavating the inner section surrounded by the outer shell lining body, the first end wall, and the second end wall.

[0016]

According to the above-described construction method of the large underground space, the first end wall can be installed in a region of the inner section of the structurally stable circumference shield tunnel. Accordingly, it is possible to build the first end wall itself in a structurally excellent state. Therefore, the excavation work of the inner section surrounded by the outer shell lining body, the first end wall, and the second end wall can be carried out in a space in a structurally stable state.

[0017]

(5) In the large underground space constructing method according to (4) described above, the ground improvement zone may be constructed using a boring machine for improvement work which starts to move outward from one of the permanent shield tunnels.

[0018]

In this case, the boring machine for improvement work starting to move outward from the permanent shield tunnel is used. Accordingly, the ground improvement zone can be efficiently constructed in a desired region required as the launching shaft for shields circumferential shield.

[0019]

(6) According to another aspect of the present invention, there is provided a launching base for outer shell shield using a large underground space constructing method in which when an enlarged tunnel part forming a tunnel branch confluence part of two permanent shield tunnels is constructed by excavating ground, construction work
5 of two permanent shield tunnels is constructed by excavating ground, construction work is carried out in an outer section at a planned excavated point of the enlarged tunnel part in a state where a plurality of outer shell shield tunnels are arranged in advance in a tunnel circumferential direction so as to build an outer shell lining body for surrounding the planned excavated point with the outer shell shield tunnels, and so as to excavate an
10 inner section of the outer shell lining body. A plurality of circular section circumference shield tunnels are simultaneously installed with an interval therebetween, along a circumferential direction in which a direction parallel to a tunnel axial direction of any one of the permanent shield tunnels serves as a central axis of the circumference shield tunnel, around the two permanent shield tunnels. A plurality of adit tunnels for
15 connecting the adjacent circumference shield tunnels to each other are installed along the circumferential direction with the interval therebetween. The plurality of circumference shield tunnels and the plurality of adit tunnels are used as a launching base under the ground of an outer shell shield machine for excavating the plurality of outer shell shield tunnels.

20 [0020]

In this case, when the outer shell lining body is built by the plurality of outer shell shield tunnels, the portion formed by connecting the plurality of circular section circumference shield tunnels extending along the circumferential direction to each other using the plurality of adit tunnels can be used as the launching base under the ground of
25 the outer shell shield tunnel. The circumference shield tunnel can be bored along the

circumferential direction by the general circular section shield excavator. In addition, a required space can be secured as the starting base of the outer shell shield tunnel by excavating and connecting the circumference shield tunnels to each other in the horizontal direction. Therefore, compared to the case of using the rectangular section shield excavator in the related art, the construction work is simply carried out, and thus, it is possible to achieve a reduced cost.

In addition, in this case, the circumference shield tunnel has a structurally stable circular section, and is structurally and advantageously resistant against the earth-water pressure of the ground. For example, compared to the rectangular section, the thickness of the segments can be minimized, and thus, the cost can be reduced.

[0021]

(7) In the launching base for outer shell shield according to (6) described above, a wall surface of a start zone of the outer shell shield machine may be configured to include a material which is capable of cutting using the outer shell shield machine.

[0022]

In this case, the wall surface of the start zone of the outer shell shield machine is configured in advance to include the cuttable material. Accordingly, the outer shell shield machine located at a predetermined start position in the circumference shield tunnel can start to move forward while the wall surface of the start zone is cut using a cutting cutter of the outer shell shield machine.

Advantageous Effects of Invention

[0023]

According to the large underground space constructing method and the launching base for outer shell shield in the respective aspects of the present invention, it

is possible to suppress an increase in scale, and it is possible to construct a low cost, structurally stable, compact, and reasonable structure for a launching base under the ground.

5 Brief Description of Drawings

[0024]

FIG. 1 is a plan view showing a construction state of an enlarged tunnel part according to an embodiment of the present invention.

FIG. 2 is a perspective view showing the construction state of the enlarged
10 tunnel part shown in FIG. 1.

FIG. 3 is a perspective view showing a construction state of a circumference shield tunnel, and is a view for visually showing an interior of a first circumference shield tunnel.

FIG. 4 is a sectional view when the construction state of the circumference
15 shield tunnel is viewed in a tunnel axial direction.

FIG. 5 is a sectional view taken along line A-A shown in FIG. 1.

FIG. 6 is a sectional view of a portion where the circumference shield tunnels are connected to each other using a connection portion in a launching base under the ground.

20 FIG. 7 is a side view showing a configuration of a sharp curve shield excavator.

FIG. 8 is a plan view when a construction state of a launching shaft for shields circumferential shield is viewed from above.

FIG. 9A is a view showing a construction procedure of the enlarged tunnel part.

FIG. 9B is a view showing a construction procedure of the enlarged tunnel part,
25 which is subsequent to FIG. 9A.

FIG. 10A is a view showing a construction procedure of the enlarged tunnel part, which is subsequent to FIG. 9B.

FIG. 10B is a view showing a construction procedure of the enlarged tunnel part, which is subsequent to FIG. 10A.

5 FIG. 11A is a view showing a construction procedure of the enlarged tunnel part, which is subsequent to FIG. 10B.

FIG. 11B is a view showing a construction procedure of the enlarged tunnel part, which is subsequent to FIG. 11A.

FIG. 12A is a view showing a construction procedure of the enlarged tunnel part,
10 which is subsequent to FIG. 11B.

FIG. 12B is a view showing a construction procedure of the enlarged tunnel part, which is subsequent to FIG. 12A.

Description of Embodiments

15 [0025]

Hereinafter, a large underground space constructing method and a launching base for outer shell shield according to an embodiment of the present invention will be described with reference to the drawings.

[0026]

20 As shown in FIGS. 1 and 2, the large underground space constructing method according to the present embodiment is applied to the following construction work. For example, in a road tunnel, the construction work is carried out so as to build an enlarged tunnel part 1 in a location where a ramp shield tunnel 12 (permanent shield tunnel) converges to or diverges from a main shield tunnel 11 (permanent shield tunnel)
25 constructed underground in advance.

[0027]

According to the present embodiment, the ramp shield tunnel 12 converging to or diverging from the main shield tunnel 11 is constructed earlier than the main shield tunnel 11. A plurality of outer shell shield tunnels 13 and 13 are constructed in an outer
5 section of the main shield tunnel 11 and the ramp shield tunnel 12, in a state of being arranged in a circumferential direction E in which a direction parallel to a tunnel axial direction X of the main shield tunnel 11 serves as a central axis of the outer shell shield tunnels 13 and 13. In this manner, an outer shell lining body 1A is built so that a
10 planned excavated point is surrounded by the outer shell shield tunnels 13. That is, the enlarged tunnel part 1 is built by excavating an inner section of the outer shell lining body 1A surrounding the main shield tunnel 11 and the ramp shield tunnel 12.

The outer shell shield tunnel 13 can be bored and constructed by an outer shell shield machine 14.

According to the present embodiment, the main shield tunnel 11 and the ramp
15 shield tunnel 12 are constructed using a known shield construction method.

[0028]

As shown in FIGS. 3 and 5, the outer shell shield machine 14 starts to bore the outer section of the main shield tunnel 11 and the ramp shield tunnel 12 from a launching base under the ground 15 (launching base for outer shell shield) formed in a ring shape
20 along the circumferential direction E.

As shown in FIG. 1, the outer shell shield tunnel 13 is constructed by causing the outer shell shield machine 14 to bore the outer shell shield tunnel 13 up to a predetermined arrival position.

[0029]

As shown in FIG. 6, the launching base under the ground 15 is configured to include two circular section circumference shield tunnels 10 (10A and 10B) constructed using a sharp curve shield excavator 2, and a plurality of adit tunnels 102 for connecting the circumference shield tunnels 10A and 10B to each other in the tunnel axial direction

5 X. An outer diameter of one first circumference shield tunnel 10A is set to a dimension which enables the outer shell shield machine 14 to start (refer to FIG. 5). An outer diameter of the other second circumference shield tunnel 10B may be set to a diameter dimension suitable for transporting construction materials. However, according to the present embodiment, the outer diameter is set to be the same as that of the first
10 circumference shield tunnel 10A.

[0030]

As shown in FIG. 2, a wall surface 151 (working place) in a start zone 15 of the outer shell shield machine 14, which is located in the first circumference shield tunnel 10A in the launching base under the ground 15 has an outer wall formed using a segment
15 103 when the construction work is carried out. However, similar to a general shield construction method, the outer wall is constructed in advance at a proper timing by using a material, for example, such as carbon fiber-containing concrete which is capable of cutting using the cutting cutter. It is also possible to use the segment 103 in which the wall surface 151 formed of the material which is capable of cutting using the cutting
20 cutter is incorporated.

[0031]

Here, as shown in FIG. 2, the sharp curve shield excavator 2 is used when excavating the circumference shield tunnel 10 forming the launching base under the ground 15 from which the outer shell shield machine 14 starts to move. The sharp
25 curve shield excavator 2 includes a cutter on an excavating surface, and is adapted to

bore the tunnel so that tunnel alignment can draw a prescribed curve. Then, the segment 103 (FIG. 3) assembled in a cylindrical shape is connected to a rear portion of the sharp curve shield excavator 2 in a tunnel boring direction, and the circumference shield tunnel 10 is sequentially extended and built.

5 [0032]

In addition, FIG. 7 shows a detailed configuration of the sharp curve shield excavator 2. FIG. 7 is a side view in which a curved inner circumference 10a in the sharp curve shield excavator 2 and the circumference shield tunnel 10 is located in proximity to the bottom of the paper in FIG. 7 and a curved outer circumference 10b is located in proximity to the top of the paper.

The sharp curve shield excavator 2 has the following configuration. Expansion and contraction strokes of a propulsion jack 24 are set so that the stroke in proximity to the curved outer circumference 10b is longer than the stroke in proximity to the curved inner circumference 10a in accordance with the tunnel alignment (alignment of the circumference shield tunnel 10). A skin plate 20 is folded in two in accordance with the tunnel alignment. Since the shield excavator having this configuration is used, even if the tunnel alignment is a sharp curve, the boring can be carried out without the skin plate 20 coming into contact with excavated rock mass.

[0033]

20 The sharp curve shield excavator 2 includes a shield machine main body 2A having the cylindrical skin plate 20 forming an outer shell, and a cutter head 3 having a plurality of cutter bits installed in proximity to the front of the shield machine main body 2A. Although not particularly shown, in the sharp curve shield excavator 2 according to the present embodiment, an earth discharging mechanism such as a sludge drainage pipe

and a mechanism for injecting a mud addition agent into a chamber inside the cutter head 3 are arranged at appropriate positions.

[0034]

Here, a central axis line passing through a center of each cross section of the circumference shield tunnels 10 (10A and 10B) will be referred to as a tunnel central axis O. The central axis line passing through the center of the cutter head 3 will be referred to as a first central axis O1. The central axis line passing through the center of the shield machine main body 2A will be referred to as a second central axis O2. The first central axis O1 and the second central axis O2 intersect each other at a predetermined tilt angle. A direction along the central axis O will be referred to as a forward-rearward direction. A portion in proximity to a working place along the forward-rearward direction will be referred to as a front portion or forward. A portion in proximity to a side opposite thereto (close to the starting base) will be referred to as a rear portion or rearward. In addition, a direction orthogonal to the forward-rearward direction will be referred to as a tunnel radial direction. A direction turning around the forward-rearward direction will be referred to as a tunnel circumferential direction F.

[0035]

The shield machine main body 2A includes the cylindrical skin plate 20 in which a front body 20A is bent at a predetermined tilt angle with respect to a rear body 20B, a partition wall 21 arranged in front of the skin plate 20 so as to forming a division wall which partitions the working place and an interior of the shield machine, a cutter ring 22 installed on the partition wall 21, a ring-shaped main body ring 23 installed in an intermediate portion in a length direction of the skin plate 20 and located behind the partition wall 21, a plurality of propulsion jacks 24 installed in the main body ring 23 with an interval in the tunnel circumferential direction F, and an erector device 25

installed in a central portion in the tunnel radial direction of the main body ring 23 via a pivot shaft portion 27.

[0036]

A tail seal 20a for sealing a gap S from an outer circumferential surface of the assembled segment 103 is installed over the entire periphery in proximity to the inner circumference of the rear portion of the skin plate 20. The partition wall 21 is configured to include an outer circumferential partition wall 21A formed in a ring shape near the outer circumference in the tunnel radial direction, and an inner circumferential partition wall 21B formed in a disc shape pinching the cutter ring 22 in the inner section in the tunnel radial direction of the outer circumferential partition wall 21A. The outer circumferential partition wall 21A and the inner circumferential partition wall 21B are installed coaxially with each other in the first central axis O1. A center cutter 31 of the cutter head 3 is fixed to the center in the tunnel radial direction of the inner circumferential partition wall 21B.

[0037]

The cutter ring 22 is located coaxially with the inner circumferential partition wall 21B. A ring gear formed on the outer circumferential surface is rotatably installed by meshing with each rotary shaft 26a of a plurality of cutter drive motors 26 located with an interval in the tunnel circumferential direction F in an inner circumferential portion 21a of the outer circumferential partition wall 21A.

A portion of the curved outer circumference 10b in the outer circumferential partition wall 21A is provided with a movable sled 211 which can protrude toward the outer section in the tunnel radial direction. The movable sled 211 causes a protruding end surface 211a to protrude so as to be pressed against rock mass. In this manner, the

sharp curve shield excavator 2 can carry out the boring work, while a counterforce of a force directed toward the outer section of the curve is taken by the rock mass.

[0038]

The cutter head 3 includes the center cutter 31 and a plurality of spokes 32
5 extending radially from the center cutter 31 in the tunnel radial direction. The first central axis O1 tilts toward the curved inner circumference 10a with respect to the second central axis O2 of the main central ring 23. Some of the plurality of spokes 32 are equipped with a copy cutter 33 which is retractable in the radial direction from a spoke tip. Then, the rear end of the center cutter 31 is provided with a rotary joint 34
10 supported by the cutter ring 22.

Then, in the propulsion jack 24, the expansion and contraction stroke in proximity to the curved inner circumference 10a is set to be shorter than that in proximity to the curved outer circumference 10b.

[0039]

15 In addition, the main body ring 23 is provided with the pivot shaft portion 27 extending rearward in the central portion in the tunnel radial direction, and a revolving frame 28 located in proximity to the rear end of the pivot shaft portion 27 and rotated in the tunnel circumferential direction F. Then, the erector device 25 is supported by the revolving frame 28.

20 The erector device 25 includes a gripping device 251 having a gripping portion 251a for detachably gripping the segment 103, an upward-downward cylinder 254 for moving the gripping device 251 upward and downward, and a slide jack (not shown) which causes the gripping device 251 to slide in the forward-rearward direction.

[0040]

In addition, according to the present embodiment, when the circumference shield tunnel 10 is constructed, in a state where a plurality of segment pieces are loaded as shown in FIG. 4, a segment car 4 is used which travels on a track inside the circumference shield tunnel 10 from the proximity of the starting base of the circumference shield tunnel 10 so as to supply pieces one by one to the erector device 25 of the above-described sharp curve shield excavator 2. The segment car 4 enables the loaded segment 103 to enter between the erector device 25 and a tunnel inner circumferential surface.

[0041]

10 Next, a constructing method of the above-described enlarged tunnel part 1 will be described in detail with reference to the drawings.

As shown in FIGS. 1 and 2, the constructing method of the enlarged tunnel part 1 according to the present embodiment has a construction process of constructing the two the circumference shield tunnels 10A and 10B around the main shield tunnel 11 and the ramp shield tunnel 12 with an interval therebetween along the circumferential direction E, a construction process of constructing the plurality of adit tunnels 102 and 102 for connecting the two adjacent circumference shield tunnels 10A and 10B to each other with an interval along the circumferential direction E, and a construction process of boring the plurality of outer shell shield tunnels 13 and 13 by using the two circumference shield tunnels 10A and 10B and the plurality of adit tunnels 102 as the launching base under the ground 15.

[0042]

25 According to this construction method, at the planned excavated point of the enlarged tunnel part 1, the ramp shield tunnel 12 which converges to or diverges from the main shield tunnel 11 is constructed.

First, as shown in FIGS. 8 and 9A, the starting base of the two circumference shield tunnels 10A and 10B (hereinafter, referred to as a “launching shaft for shields circumferential shield 101”) is installed in a section of the ramp shield tunnel 12. Then, in order to construct the launching shaft for shields circumferential shield 101, ground improvement work for forming a freezing wall 100 (ground improvement zone) by using a freezing method is carried out for the ground around a construction region of the launching shaft for shields circumferential shield 101.

[0043]

According to the freezing method in this case, as shown in FIG. 8, a circular section propulsion machine 16 (boring machine for improvement work) using a propulsion construction method starts the boring work from the ramp shield tunnel 12 toward the outer section in the radial direction of the ramp shield tunnel 12. In this case, the freezing wall 100 is installed by radially arranging a plurality of freezing ducts 104 from the propulsion machine 16. In addition, if necessary, the freezing ducts are arranged from the ramp shield tunnel. Thereafter, the ground of the inner section of the freezing wall 100 is excavated using a constructing method in the related art, thereby building the launching shaft for shields circumferential shield 101 having a region formed in a substantially rectangular box shape. Then, the launching shaft for shields circumferential shield 101 is excavated, and the propulsion machine 16 is removed.

In addition, as shown in FIG. 8, if necessary, the freezing ducts 105 may be arranged on the ground around the construction region from the ramp shield tunnel 12 so as to carry out the ground improvement work (refer to FIG. 2).

[0044]

The propulsion machine 16 or the ground improvement work carried out from the ramp shield tunnel 12 is not limited to the above-described freezing method. For

example, another ground improvement work can be employed such as chemical grouting work for injecting a chemical by installing an injection pipe from the rear of the propulsion machine 16 toward a target improvement region.

As shown in FIGS. 1 and 2, a size of the launching shaft for shields
5 circumferential shield 101 is set to a size so that the sharp curve shield excavators 2 respectively boring the two circumference shield tunnels 10A and 10B are arranged with a predetermined distance therebetween.

[0045]

Next, inside the launching shaft for shields circumferential shield 101, the sharp
10 curve shield excavator 2 is assembled, and subsequent facilities needed to receive the counterforce and to carry out the boring work are installed so as to prepare for starting. According to the present embodiment, the second circumference shield tunnel 10B is constructed earlier. Then, the sharp curve shield excavator 2 set in the launching shaft for shields circumferential shield 101 is installed so that the first central axis O1 of the
15 cutter head 3 shown in FIG. 7 coincides with the central axis line O of the circumference shield tunnel 10.

[0046]

Next, as shown in FIGS. 1, 2, 4, 9B, and 10A, the sharp curve shield excavator 2 starts to move forward, the excavation work is carried out using a method the same as the
20 shield construction method in the related art. The segment 103 is assembled, and work for injecting a back-filling material between the segment 103 and the rock mass is sequentially and repeatedly carried out. The outer section of the main shield tunnel 11 and the ramp shield tunnel 12 is bored in the circumferential direction E so as to arrive again in the launching shaft for shields circumferential shield 101. In this manner, the
25 circumference shield tunnel 10 can be built.

In this way, the first one of the second circumference shield tunnel 10B is installed, and the second one of the first circumference shield tunnel 10A is constructed using the same procedure so as to extend along the constructed second circumference shield tunnel 10B.

5 [0047]

Next, as shown in FIGS. 6 and 10B, the ground improvement work is carried out between the two circumference shield tunnels 10A and 10B by using the freezing method or the chemical injection construction method. Thereafter, both the circumference shield tunnels 10A and 10B are connected to each other using the excavated adit tunnel 102. The plurality of adit tunnels 102 are installed corresponding to the start positions of the outer shell shield machine 14, and are arranged with an interval in the circumferential direction E. In this manner, the launching base under the ground 15 is completed using the two circumference shield tunnels 10A and 10B and the plurality of adit tunnels 102 and 102.

15 As shown in FIG. 6, the adit tunnel 102 leads to the interior of the two circumference shield tunnels 10A and 10B. Accordingly, the launching base under the ground 15 has a space R which is linearly communicable along the tunnel axial direction X. This space R is used as the starting base of the outer shell shield machine 14 (refer to FIG. 5). In a case of the present embodiment, the first circumference shield tunnel 10A serves as a start zone of the outer shell shield machine 14, and the second circumference shield tunnel 10B serves as a construction material loading location. Therefore, the first circumference shield tunnel 10A is set to have a size so that the completed outer shell shield machine 14 can be loaded and can start to move forward. In addition, the wall surface (working place) of the start zone of the outer shell shield

machine 14 in the launching base under the ground 15 is constructed in advance using a material which can be cut by the cutter.

[0048]

After the launching base under the ground 15 is constructed, as shown in FIG. 5, the plurality of outer shell shield machines 14 are loaded into the launching base under the ground 15 via the ramp shield tunnel 12. As shown in FIGS. 1, 2 and 11A, the plurality of outer shell shield machines 14 are arranged one by one or all simultaneously with a predetermined interval along the circumferential direction E so as to carry out the boring work. In this manner, the plurality of outer shell shield tunnels 13 are constructed. Then, the excavated earth and sand are delivered into the ramp shield tunnel 12 via the launching base under the ground 15, and are unloaded outward. The construction materials such as the segment required for the boring work are unloaded from the interior of the ramp shield tunnel 12 into the outer shell shield tunnel 13 via the launching base under the ground 15.

[0049]

Next, as shown in FIGS. 2, 5, and 11B, all of the outer shell shield machines 14 start to move forward, and the main shield tunnel 11 passes through the position of the first circumference shield tunnel 10A. Thereafter, a first end wall 17 formed of reinforced concrete, for example, is installed in the inner section surrounded by the first circumference shield tunnel 10A. Specifically, the ground improvement work is carried around the first circumference shield tunnel 10A (at least an inner section portion of the first circumference shield tunnel 10A). The outer shell shield machine 14 is allowed to have access from at least any one of the first circumference shield tunnel 10A, the main shield tunnel 11, and the ramp shield tunnel 12, thereby building the first end wall 17.

[0050]

Thereafter, as shown in FIG. 11B, if all of the outer shell shield machines 14 arrive at a predetermined underground arrival point, the outer shell shield machines 14 are disassembled and collected in the underground arrival point in a state where the skin plate is left behind.

5 Next, as shown in FIG. 12A, a second end wall 18 formed of reinforced concrete, for example, is installed in the underground arrival point. Specifically, the ground improvement is carried out around the main shield tunnel 11, and the access is allowed from a portion of the main shield tunnel 11 so as to build the second end wall 18 in the underground arrival point at which the plurality of outer shell shield tunnels 13 arrive.

10 The first end wall 17 and the second end wall 18 are not limited to walls formed of the reinforced concrete. For example, both of these may be ground improvement walls formed using the freezing method or the chemical injection construction method.

[0051]

 Then, the ground improvement work is carried out between the outer shell shield
15 tunnels 13 and 13 adjacent to each other in the circumferential direction E by using the freezing method or the chemical injection construction method. Thereafter, the outer shell shield tunnels 13 and 13 are integrated by being connected to each other as an open-cut structure. In this manner, the outer shell lining body 1A having a supporting function and a waterproofing function is built.

20 [0052]

 Next, as shown in FIG. 12B, the inner section surrounded by the outer shell lining body 1A, the first end wall 17, and the second end wall 18 is excavated. In this case, the segment of the main shield tunnel 11 and the ramp shield tunnel 12 located in the inner section of the outer shell lining body 1A is disassembled and removed, thereby
25 forming the enlarged tunnel part 1.

[0053]

Next, the above-described large underground space constructing method and an operation of the launching base for outer shell shield will be described in detail with reference to the drawings.

5 As shown in FIGS. 1 and 2, according to the present embodiment, when the outer shell lining body 1A is built using the plurality of outer shell shield tunnels 13 and 13, a portion formed by connecting the two circumference shield tunnels 10A and 10B extending along the circumferential direction E to each other using the plurality of adit tunnels 102 can be used as the launching base under the ground 15 of the outer shell shield tunnel 13. The circumference shield tunnels 10A and 10B can be bored and constructed section along the circumferential direction E by using the general circular section sharp curve shield excavator 2. In addition, the circumference shield tunnels 10A and 10B are excavated and connected to each other in the horizontal direction. In this manner, it is possible to secure a space required as the starting base of the outer shell shield tunnel 13.

Therefore, compared to the case of using the rectangular section shield excavator in the related art, the construction work is carried out simply, and thus, it is possible to achieve a reduced cost.

[0054]

20 In addition, according to the present embodiment, the circumference shield tunnel 10 has a structurally stable circular section, and is structurally and advantageously resistant against the earth-water pressure of the ground. For example, the thickness of the segments can be minimized, and thus, the cost can be reduced.

[0055]

In addition, according to the present embodiment, the launching shaft for shields circumferential shield 101 is built using the ramp shield tunnel 12, and the circumference shield machine starts to carry out the boring work from the launching shaft for shields circumferential shield 101 in the circumferential direction E. In this way, the circumference shield tunnel 10 can be installed. Therefore, it is not necessary to carry out large-scale construction work which has to be carried out by excavating a pit from the ground level for the launching shaft for shields circumferential shield 101. The construction does not receive any limitation of the construction site on the ground. Therefore, it is possible to achieve a reduced construction cost and a reduced construction period.

[0056]

Furthermore, according to the present embodiment, the launching shaft for outer shell shield of the first circumference shield tunnel 10A and the material delivery adit of the second circumference shield tunnel 10B are respectively and independently installed, and are connected to each other using the adit tunnels 108. In this manner, mutual work sites are less affected by each other. It is possible to configure the starting base of the outer shell shield tunnel 13 whose unnecessary space is minimized. Therefore, it is possible to achieve efficiency in construction work and a reduced cost.

[0057]

In addition, according to the present embodiment, the first end wall 17 can be installed in the region of the inner section of the first circumference shield tunnel 10A which is structurally stable. Accordingly, it is possible to build the first end wall 17 itself in a structurally excellent state. Therefore, the excavation work of the inner section surrounded by the outer shell lining body, the first end wall 17, and the second end wall 18 can be carried out in the space in a structurally stable state.

[0058]

In addition, according to the present embodiment, the circumference shield tunnel 10 has the circular section. Accordingly, the excavator only needs a space in which the sharp curve shield excavator 2 can normally start to move forward.

5 Accordingly, it is possible to build the launching shaft for shields circumferential shield 101 in the freezing wall 100 formed from the ramp shield tunnel 12.

Moreover, in this case, as shown in FIG. 8, the propulsion machine starting to move outward from the ramp shield tunnel 12 is used. Accordingly, the freezing wall 100 can be efficiently constructed in a desired region required as the launching shaft for
10 shields circumferential shield 101.

[0059]

As described above, according to the large underground space constructing method and the launching base for outer shell shield in the present invention, it is possible to suppress an increase in scale, and it is possible to construct a low cost,
15 structurally stable, compact, and reasonable structure for a launching base under the ground.

[0060]

Hitherto, the embodiment of the large underground space constructing method and the launching base for outer shell shield according to the present invention has been
20 described. However, the present invention is not limited to the above-described embodiment, and may be appropriately modified within the scope not departing from the gist of the present invention.

For example, according to the present embodiment, construction target is set as follows. The ramp shield tunnel 12 is constructed earlier, and the construction is carried
25 out so that the main shield tunnel 11 arrives at the tunnel branch confluence part,

subsequently to the ramp shield tunnel 12. However, the present invention is not limited to this construction work. For example, even in a case where the main shield tunnel 11 is constructed earlier and the ramp shield tunnel 12 arrives at the tunnel branch confluence part, subsequently to the main shield tunnel 11, if the main shield tunnel 11 is still bored, and if the launching base for outer shell shield (launching base under the ground 15) is installed in the main shield tunnel 11 as disclosed in Patent Document 2 (Japanese Unexamined Patent Application, First Publication No. 2014-43738) described above, transportation work resulting from the boring work of the main shield tunnel 11, building work of the outer shell shield tunnel the starting base, and transportation work of the outer shell shield machine 14 are complicated, thereby causing a problem in terms of a construction period and safety. Therefore, it is effective to adopt the present invention.

In this way, even in a case where any shield tunnel is constructed earlier between the main shield tunnel 11 and the ramp shield tunnel 12, the excavation work is carried out after the end wall is built in a state where both the shield tunnels are always located in the zone surrounded by the outer shell lining body 1A. If any shield tunnel arrives at the zone after the end wall is built, useless work for cutting the end wall has to be carried out. In addition, since it is necessary to carry out waterproofing work in the cut boundary portion, it is not preferable.

[0061]

In addition, a position or a size of the launching base under the ground 15 configured to include the circumference shield tunnels 10A and 10B can be appropriately set depending on conditions such as the outer diameter of the main shield tunnel 11 or the ramp shield tunnel 12, the outer diameter or specifications of the outer shell shield machine 14, and the rock mass.

Then, according to the present embodiment, the number of the constructed circumference shield tunnels 10 is two. However, three or more circumference shield tunnels 10 may be constructed with an interval so as to be connected to each other using the adit tunnel 102.

5 [0062]

Furthermore, according to the present embodiment, the first end wall 17 and the second end wall 18 are installed in both end portions in the tunnel axial direction X of the outer shell lining body 1A. However, these end walls can be omitted, or only any one of the end walls may be installed. For example, according to the present embodiment, 10 the second end wall 18 is installed between the underground arrival point and the main shield tunnel 11. However, in a case where the underground arrival point is installed so as to be in contact with the outer circumference of the main shield tunnel 11, the second end wall 18 can be omitted.

[0063]

15 Furthermore, the present embodiment is an application example in a case of constructing a large cross-section road tunnel. However, the present embodiment is generally and widely applicable to a case of constructing various scales, applications, and forms of tunnels having the large underground space as described above. Various design modifications are available depending on the scale or the form of the large 20 underground space in a construction target tunnel, or in view of various conditions in the surrounding environment.

[0064]

In addition, when the construction work is carried out for the launching shaft for shields circumferential shield 101 serving as the start zone of the circumference shield 25 tunnel 10, a range or a form of the ground improvement zone constructed before the

excavation work by using the freezing method, a constructing method thereof, and details of other respective construction processes may be optimally designed within the scope not departing from the gist of the present invention. As a matter of course, an auxiliary construction method may be appropriately adopted, if necessary.

5 [0065]

Alternatively, the configuration elements in the above-described embodiment can be appropriately substituted with known configuration elements within the scope not departing from the gist of the present invention.

10 Industrial Applicability

[0066]

According to the large underground space constructing method and the launching base for outer shell shield in the present invention, it is possible to suppress a increase in scale, and it is possible to construct a low cost, structurally stable, compact,
15 and reasonable structure for a launching base under the ground.

Reference Signs List

[0067]

- 1 enlarged tunnel part
- 20 1A outer shell lining body
- 2 sharp curve shield excavator
- 10, 10A, 10B circumference shield tunnel
- 10a curved inner circumference
- 10b curved outer circumference
- 25 11 main shield tunnel (permanent shield tunnel)

- 12 ramp shield tunnel (permanent shield tunnel)
- 13 outer shell shield tunnel
- 14 outer shell shield machine
- 15 launching base under the ground (launching base for outer shell shield)
- 5 16 propulsion machine (boring machine for improvement work)
- 17 first end wall
- 18 second end wall
- 100 freezing wall (ground improvement zone)
- 101 launching shaft for shields circumferential shield
- 10 102 adit tunnel
- 103 segment
- E circumferential direction
- X tunnel axial direction

CLAIMS

What is claimed is:

1. A large underground space constructing method in which when an enlarged tunnel part forming a tunnel branch confluence part of two permanent shield tunnels is
5 constructed by excavating ground, construction work is carried out in an outer section at a planned excavated point of the enlarged tunnel part in a state where a plurality of outer shell shield tunnels are arranged in advance in a tunnel circumferential direction so as to build an outer shell lining body for surrounding the planned excavated point by the outer shell shield tunnels, and so as to excavate an inner section of the outer shell lining body,
10 the construction method comprising:
a construction process of simultaneously constructing a plurality of circular section circumference shield tunnels with an interval therebetween, along a circumferential direction in which a direction parallel to a tunnel axial direction of any one of the permanent shield tunnels serves as a central axis of the circumference shield
15 tunnel, around the two permanent shield tunnels;
a construction process of constructing a plurality of adit tunnels for connecting the adjacent circumference shield tunnels to each other along the circumferential direction with the interval therebetween; and
a construction process of boring the plurality of outer shell shield tunnels by
20 using the plurality of circumference shield tunnels and the plurality of adit tunnels as a launching base under the ground.
2. The large underground space constructing method according to claim 1, further comprising:

a construction process of forming a ground improvement zone around a portion of any one permanent shield tunnel between the two permanent shield tunnels; and

a construction process of building a launching shaft for shields circumferential shield for starting work of the circumference shield tunnel in the ground improvement
5 zone.

3. The large underground space constructing method according to claim 1 or 2, wherein after the plurality of adit tunnels are installed by simultaneously constructing the two circumference shield tunnels, one of the circumference shield
10 tunnels is used as a launching shaft for outer shell shield, and the other one of the circumference shield tunnels is used as a material delivery adit.

4. The large underground space constructing method according to any one of claims 1 to 3, further comprising:

15 a construction process of forming the outer shell lining body by connecting the plurality of outer shell shield tunnels to each other in the circumferential direction;

a construction process of installing a first end wall in an inner section surrounded by the circumference shield tunnels;

a construction process of installing a second end wall in an arrival point of the
20 circumference shield tunnels; and

a construction process of excavating the inner section surrounded by the outer shell lining body, the first end wall, and the second end wall.

5. The large underground space constructing method according to claim 4,

wherein the ground improvement zone is constructed using a boring machine for improvement work which starts to move outward from one of the permanent shield tunnels.

- 5 6. A launching base for outer shell shield using a large underground space constructing method in which when an enlarged tunnel part forming a tunnel branch confluence part of two permanent shield tunnels is constructed by excavating ground, construction work is carried out in an outer section at a planned excavated point of the enlarged tunnel part in a state where a plurality of outer shell shield tunnels are arranged
10 in advance in a tunnel circumferential direction so as to build an outer shell lining body for surrounding the planned excavated point with the outer shell shield tunnels, and so as to excavate an inner section of the outer shell lining body,

 wherein a plurality of circular section circumference shield tunnels are simultaneously installed with an interval therebetween, along a circumferential direction
15 in which a direction parallel to a tunnel axial direction of any one of the permanent shield tunnels serves as a central axis of the circumference shield tunnel, around the two permanent shield tunnels,

 wherein a plurality of adit tunnels for connecting the adjacent circumference shield tunnels to each other are installed along the circumferential direction with the
20 interval therebetween, and

 wherein the plurality of circumference shield tunnels and the plurality of adit tunnels are used as a launching base under the ground of an outer shell shield machine for excavating the plurality of outer shell shield tunnels.

- 25 7. The launching base for outer shell shield according to claim 6,

wherein a wall surface of a start zone of the outer shell shield machine is formed of a material which is capable of cutting using the outer shell shield machine.