

5 SEGMENT FOR A REHABILITATION PIPE, AND PIPE REHABILITATION
METHOD

BACKGROUND OF THE INVENTION

Field of the Invention

10 The present invention relates to a segment for a
rehabilitation pipe comprising an inner surface plate
constituting an inner circumferential surface, and side
plates and end plates provided upright on peripheral edges
of the inner surface plate, wherein the inner surface plate,
15 the side plates, and the end plates are formed integrally
from a plastic material and the segments are linked in the
circumferential direction and in the pipe-length direction
to construct a rehabilitation pipe inside an existing pipe.
The present invention also relates to a pipe rehabilitation
20 method using the segments.

Description of the Related Art

 In cases in which a sewage pipe or another pipeline
buried underground has deteriorated through aging, a pipe
lining method has been proposed and practiced in which a
25 lining is provided to the inner circumferential surface
thereof to repair the pipeline without excavating it from

the ground.

In this pipe lining method, a pipe lining material made of a tubular resin absorbent material impregnated with an uncured thermosetting resin is everted and inserted into a pipeline using fluid pressure, and is pressed by fluid pressure against the inner peripheral wall of the pipeline. The lining material is then heated using a desired method to cure the thermosetting resin therein and form a plastic pipe, thereby repairing the pipeline.

There is also known a lining method using segments each comprising an inner surface plate constituting an inner circumferential surface, side plates and end plates provided upright on the peripheral edges of the inner surface plate, these plates being integrally formed from a plastic material. The segments are linked in the circumferential direction to assemble short pipe units, which are then linked in the pipe-length direction to construct a rehabilitation pipe inside an existing pipe (for example, JP-A 2005-264635). Such a pipe rehabilitation method is used for large-diameter existing pipes. In this method, after assembling a rehabilitation pipe inside the existing pipe, grout or another filler material is injected into a space between the existing pipe and the rehabilitation pipe and hardened to construct a composite pipe.

SUMMARY OF THE INVENTION

The present disclosure provides a segment for a rehabilitation pipe, the segment comprising: an inner surface plate having an inner circumferential surface, and side plates and end plates provided upright on a peripheral edge of the inner surface plate; wherein the inner surface plate, the side plates, and the end plates are formed integrally from a plastic material and the segments are linked in a circumferential direction and in a pipe-length direction to install a segmental rehabilitation pipe inside an existing pipe; wherein each of the side plates is provided with at least one hole through which a linking member is inserted for linking the segments in the pipe-length direction, and is provided separately from the hole with an opening at an end in the vicinity of the end plate for a linking operation of the segments in the circumferential direction and for passing therethrough a filler material injected into a space between the existing pipe and the rehabilitation pipe, and wherein each of the end plates has at least one hole through which another linking member is inserted for linking the segments in the circumferential direction, the openings of the side plates being configured so that when the segments are connected in the circumferential direction, the another linking member is inserted through the at least one hole of each of the end plates and positioned and/or tightened through the openings of the side plates.

The present disclosure also provides a pipe unit for a rehabilitation pipe used to rehabilitate an existing pipe, the pipe unit comprising a plurality of segments as described above mutually linked in a circumferential direction of the pipe unit.

The present disclosure further provides a rehabilitation pipe for rehabilitating an existing pipe, the rehabilitating pipe comprising: a plurality of pipe units as described above mutually coupled together in a longitudinal direction of the existing pipe to assemble the rehabilitating pipe.

The present disclosure still further provides a pipe rehabilitation method for installing a rehabilitation pipe inside an existing pipe, the method comprising: providing a plurality of segments each comprised of an inner surface plate having an inner circumferential surface, and side plates and end plates provided upright on a peripheral edge of the inner surface plate, each of the side plates being provided with at least one hole through which a linking member is inserted for linking the segments in a pipe-length direction, and being provided separately from the hole with an opening at an end in the vicinity of the end plate for a linking operation of the segments in the circumferential direction and for passing therethrough a filler material injected into a

space between the existing pipe and the rehabilitation pipe, the inner surface plate, the side plates, and the end plates being formed integrally from a plastic material; bringing the end plates of the segments into contact with each other; inserting a linking member into through the openings provided to the side plates of each pair of adjacent segments
5 whose end plates have been brought into contact with each other to sequentially link the segments in the circumferential direction, thereby forming a pipe unit; sequentially linking the pipe units in the pipe-length direction by inserting another linking member into the holes provided to the side plates of each pair of the adjacent segments to install a segmental rehabilitation pipe inside the existing pipe; and injecting a filler material into
10 a space between the existing pipe and the rehabilitation pipe so that the filler material passes through the openings provided to the side plates of each pair of the adjacent segments.

The present disclosure also provides, in a pipe unit for a rehabilitation pipe
15 used to rehabilitate an existing pipe, the pipe unit being formed of a plurality of segments mutually coupled together in a circumferential direction of the pipe unit, each of the segments comprising: an inner surface plate having a pair of opposite peripheral edges extending in a pipe-length direction of the rehabilitation pipe and a pair of opposite peripheral edges extending in the circumferential direction of the pipe unit; a
20 pair of end plates provided upright on the respective peripheral edges of the inner surface plate extending in the pipe-length direction, each of the end plates having at least one hole through which a linking member is inserted for linking the segments together in the circumferential direction; and a pair of side plates provided upright on the respective peripheral edges of the inner surface plate extending in the circumferential
25 direction, each of the side plates having an opening that is provided at an end thereof in the vicinity of one of the end plates and that is configured to provide access therethrough to the linking member when positioning and inserting the linking member through the holes of the end plates to sequentially link the segments together in the circumferential direction to form the pipe unit.

30 The present disclosure provides a rehabilitation pipe for rehabilitating an existing pipe, the rehabilitating pipe comprising: a plurality of pipe units as described above mutually coupled together in a pipe-length direction of the existing pipe to assemble the rehabilitating pipe.

In the rehabilitation pipe described in JP-A 2005-264635, an opening is provided to the inner surface plate of the segment in the vicinity of an edge thereof in the circumferential direction in order to facilitate tightening of a bolt for linking the segments in the circumferential direction. After the segments are linked in the circumferential direction, the segments are linked in the pipe-length direction and the rehabilitation pipe is installed in the existing pipe. If the opening is not blocked in advance, the filler subsequently injected into the space between the rehabilitation pipe and the existing pipe will flow into the rehabilitation pipe through the opening. Therefore, a problem is presented in that it is necessary to block the opening in the inner surface plate of every segment using a lid or another means after the segments are linked in the circumferential direction in order to prevent the injected filler material from flowing into the rehabilitation pipe through the opening. This makes the rehabilitation operation more complex. Also, in an instance in which the opening is blocked using a lid, it is necessary that the lid and the inner circumferential surface of the segment form a uniform surface without any unevenness. This also complicates the operation of linking the segments in the circumferential direction.

It is therefore an object of the present invention to provide a segment for a rehabilitation pipe that can be

linked in the circumferential direction in a simple manner and that can save the amount of labor involved in the overall rehabilitation operation, and to provide a pipe rehabilitation method using the segments.

5 Disclosed herein is a segment for a rehabilitation pipe comprising an inner surface plate constituting an inner circumferential surface, and side plates and end plates provided upright on a peripheral edge of the inner surface plate. The inner surface plate, the
10 side plates, and the end plates are formed integrally from a plastic material and the segments are linked in a circumferential direction and in a pipe-length direction to install a segmental rehabilitation pipe inside an existing pipe. In the present invention, each of the side plates is
15 provided at an end in the vicinity of the end plate with an opening used for a linking operation of the segments in the circumferential direction.

 Disclosed herein is a pipe
rehabilitation method for installing a rehabilitation pipe
20 inside an existing pipe using a segment that comprises an inner surface plate constituting an inner circumferential surface, and side plates and end plates provided upright on a peripheral edge of the inner surface plate, the inner surface plate, the side plates, and the end plates being
25 formed integrally from a plastic material. In the method, each of the side plates is provided at an end in the

vicinity of the end plate with an opening used for a linking operation of the segments in the circumferential direction, and the end plates of the segments are brought into contact with each other. A linking member is inserted into the opening provided to the side plate to sequentially link the segments in the circumferential direction, thereby forming a pipe unit. The thus formed pipe units are sequentially linked in the pipe-length direction to install a segmental rehabilitation pipe inside the existing pipe. The filler material is injected into the space between the existing pipe and the rehabilitation pipe to construct a composite pipe.

The side plate is provided at an end in the vicinity of the end plate with an opening used for a linking operation of the segments in the circumferential direction. Therefore, it is possible to insert a bolt, a nut, or another linking member through the opening and readily link the segments in the circumferential direction.

The opening is formed in the side plate, instead of the inner surface plate as according to conventional techniques. Therefore, the filler material injected between the rehabilitation pipe and the existing pipe after the rehabilitation pipe is assembled in the existing pipe will not flow through the opening into the rehabilitation pipe. Therefore, the need for closing the opening formed in the

side plates is obviated, and the rehabilitation operation can be made more efficient.

Also, the opening formed in the side plate is formed so that the filler material injected into the space
5 between the existing pipe and the rehabilitation pipe flows in or out through the opening. Therefore, the filler material can be injected into the space in a smoother and speedier manner, making the filling operation more efficient.

Further features of the invention, its nature and
10 various advantages will be more apparent from the accompanying drawings and following detailed description of the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

15 FIG. 1 is a perspective view showing the structure of a segment used in assembling the rehabilitation pipe;

FIG. 2a is a front view of a side plate of a segment;

FIG. 2b is a cross-sectional view along line B-B in
20 FIG. 2a;

FIG. 2c is a detailed view of an end plate of the segment viewed from the direction of line A-A in FIG. 2a;

FIG. 3a is a front view of an inner plate of the segment;

25 FIG. 3b is a cross-sectional view along line C-C in FIG. 3a;

FIG. 4 is a front view of another inner plate of the segment;

FIG. 5a is a cross-sectional view showing the segments linked in the circumferential direction with a bolt
5 and a nut;

FIG. 5b is a cross-sectional view showing the segments linked in the circumferential direction;

FIG. 5c is a front view showing the segments linked in the circumferential direction;

10 FIG. 6 is a perspective view showing a state in which the segments are linked in the circumferential direction to assemble a pipe unit;

FIG. 7 is an illustrative view showing a state in which the segments of the pipe units are linked in the pipe-
15 length direction using linking members;

FIG. 8 is an illustrative view showing a state in which the pipe units are linked and the rehabilitation pipe is installed in the existing pipe; and

FIG. 9 is a perspective view showing a state in
20 which the pipe units are linked and the rehabilitation pipe is installed in the existing pipe.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

The present invention will now be described with
25 references to embodiments illustrated in the accompanying drawings. The present invention is suitable for

rehabilitating or repairing sewage pipes, water supply pipes, tunnels, agricultural irrigation channels, and other existing large-diameter pipes. In the present embodiment, the rehabilitation pipes are described as having a circular cross-section profile orthogonal to the pipe-length direction. However, it shall be apparent that the present invention can be applied to a rehabilitation pipe having a square or another non-circular cross-section. Also, in addition to structures in which the cross-section profile is closed as a pipe, a structure having a horseshoe-shaped, semi-circular, U-shaped, or another cross-section profile in which one side is open can also be considered to be a pipe, and the present invention can also be applied thereto.

In the present specifications, the pipe-length direction refers to the direction indicated by arrow X extending in the longitudinal direction of a pipe unit 10 in FIG. 6, the radial direction refers to the direction indicated by the radial arrow R pointing towards the center axis of the pipe unit 10, and the circumferential direction refers to the direction of the circumference of the circle forming the pipe unit 10.

FIG. 1 shows the structure of a segment 1 for pipe rehabilitation (hereafter simply referred to as "segment"), which represents an assembly unit member of a rehabilitation pipe for rehabilitating an existing pipe. The segment 1 is an integrally formed block-shaped member made from a plastic

material, comprising an inner surface plate 101 constituting an inner circumferential surface of the rehabilitation pipe, side plates 102, 103 provided vertically upright on both sides extending in the circumferential direction of the inner surface plate 101, and end plates 104, 105 provided vertically upright on both ends extending in the pipe-length direction of the inner surface plate 101.

In the present embodiment, the segment 1 has a shape that is curved as an arc representing a predetermined angle that equally divides the circumference, e.g., a 60° arc that divides the circumference into sixths. However, the segment is not limited to that having an arc or a fan shape. The segment may be shaped as, e.g., a cuboid or a shape that is bent so as to have a curved right angle depending on the cross-section profile or the size of the existing pipe or the location of the existing pipe to be repaired.

A plurality (four in the present embodiment) of inner plates 106, 107 having a shape similar to that of the side plates are provided upright at equal intervals and parallel to the side plates 102, 103 on the upper surface of the inner surface plate 101 and on the inside relative to the side plates 102, 103 in order to reinforce the mechanical strength of the segment 1. One or both of the inner plates 106, 107 can be omitted if the segment 1 has sufficient strength.

The inner surface plate 101, the side plates 102, 103, the end plates 104, 105, and the inner plates 106, 107 are all made from an identical transparent, semi-transparent or opaque plastic material, and are integrally formed using
5 a known molding technique.

FIG. 2a is a detailed view of the side plates 102, 103, and FIG. 2b is a cross-section view along the line B-B in FIG. 2a. The following descriptions are given in relation to the side plate 102, but the side plate 103 has a
10 configuration similar to that of the side plate 102.

The side plate 102 is an arc-shaped thin-plate member, and an upper section 102d has a smaller plate thickness than that of a lower section 102e. This is in order to form a gap on the upper part of the two side plates
15 102, 103 when one segment is linked to another segment adjacent in the pipe-length direction, and to guide and accommodate earth and other material entering from the exterior.

A plurality of holes 102a for admitting insertion
20 of a linking member for linking the segment 1 in the pipe-length direction are provided at equal intervals along the circumference on the lower section 102e of the side plate 102. The holes 102a in the side plate 102 and holes 103a in the side plate 103 are located at coinciding positions along
25 the circumferential direction, allowing the linking member to be inserted through the holes 102a and 103a in the side

plates 102 and 103.

An opening 102b, used for a linking operation of the segments in the circumferential direction, is provided to the side plate 102 in the vicinity of both ends in the circumferential direction, i.e., at both ends in the vicinity of the end plates 104, 105. Each of the openings 102b has a rectangular shape in which corners are chamfered.

A lower edge of the opening 102b substantially coincides with a lower edge of the side plate 102, and an upper edge of the opening 102b is somewhat lower than an upper edge of the side plate 102. When the segments are connected in the circumferential direction, a bolt, a nut, or another linking member is, e.g., positioned or tightened through the opening 102b (see also FIG. 5c).

The opening 102b is configured so that a filler material injected into a space between the existing pipe and the segmental rehabilitation pipe can flow in or out through the opening 102b, and so that during injection, the filler material can pass through the opening 102b in a smooth and speedy manner. It is also possible to provide the openings 102b, 103b to the vicinity of the end plate 104 only or to the vicinity of the end plate 105 only.

Notches 102c for allowing the filler material to flow in or out and pass therethrough are provided to an upper section of the side plate 102. The notches 102c have a half-moon shape in which the upper end is open. The

notches 102c are positioned in the circumferential direction so as to be displaced from the positions of the holes 102a in the circumferential direction. More specifically, a notch 102c is provided between the hole 102a nearest to the
5 end plates 104, 105 and the next hole 102a, and then provided every two holes 102a. Thus, a total of seven notches 102c are provided to the side plate 102.

FIG. 2c is a detailed view of the end plate 105 as viewed from line A-A in FIG. 2a. The following descriptions
10 are given in relation to the end plate 105, but the end plate 104 has a configuration similar to that of the end plate 105.

The end plate 105 is a rectangular thin-plate member arranged between the side plate 102 and the side
15 plate 103. The height of the end plate 105 from the outer surface of the inner surface plate 101 is slightly lower than that of the side plates 102, 103. Circular insertion holes 105a for admitting insertion of a bolt or another linking member for linking the segment 1 in the
20 circumferential direction are provided on the end plate 105 between the side plate 102 and an inner plate 106, between the inner plate 106 and an inner plate 107, between the two inner plates 107, between the inner plate 107 and an inner plate 106, and between the inner plate 106 and the side
25 plate 103.

A concave section 101a and a convex section 101b

are provided to the inner surface plate 101 along the entire length of the circumferential direction on one end thereof in the pipe-length direction (right end in FIG. 2c). A convex section 101c and a concave section 101d are provided on the other end so that the convex/concave relationship is inverted. As a result, when the segments are linked in the pipe-length direction, the concave and convex sections of segments that are adjacent in the pipe-length direction engage with each other and fulfill the function of guiding or positioning of the segments. This facilitates the operation of linking the segments in the pipe-length direction.

A rectangular opening 105d for allowing the filler material to flow in or out and pass therethrough is provided to both sides of the inner plates 107, both sides of the inner plates 106, and the inside of the side plates 102, 103 at the lower end of the end plate 105.

A convex section 105c is provided on the end plate 105 at a position at which it intersects the inner plate 107, and is fitted into a concave section 104c provided to the corresponding position on the end plate 104 that is adjacent in the circumferential direction (see also FIG. 5b).

FIG. 3a is a detailed view of the inner plate 106, and FIG. 3b is a cross-sectional view along the line C-C in FIG. 3a. Each of the inner plates 106 is a thin-plate member having a profile substantially identical to the side

plates 102, 103. Circular holes 106a for admitting
insertion of linking members for linking the segments in the
pipe-length direction are provided at equal intervals to a
lower section of the inner plate 106. The positions of the
5 holes 106a in the circumferential direction coincide with
those of the holes 102a of the side plate 102. As shown in
FIG. 3b, the diameter of each of the holes 106a increases
from the vicinity of the center of the plate thickness of
the inner plate 106 towards the outside (i.e., the side
10 towards the side plate).

Notches 106b for allowing the filler material to
flow in or out and pass therethrough are provided to the
upper section of the inner plate 106. The notches 106b have
a half-moon shape in which the upper end is open. The
15 positions of the notches 106b are different in the
circumferential direction from those of the holes 102a, 106a.

More specifically, a notch 106b is provided further towards
the end plate than the hole 106a nearest to the end plates
104, 105, and are provided every two holes 106a. Thus, a
20 total of eight notches 106b are provided. Therefore, the
positions of the notches 106b in the circumferential
direction are displaced from those of the notches 102c of
the side plate 102 by an amount equivalent to the intervals
between the holes 106a in the circumferential direction.
25 The notches 106b and the notches 102c are thus in a
staggered arrangement when the segment is viewed from above.

This also applies to the notches 103c provided to the side plate 103 for passing the filler material, and to the notches 106b formed on the inner plate 106 adjacent to the side plate 103.

5 FIG. 4 is a detailed view of the inner plate 107. The inner plate 107 is a thin-plate member having a profile that substantially coincides with the side plates 102, 103. A plurality of notches 107a is provided from the vicinity of the lower end towards the upper end of the inner plate 107.

10 The positions of the notches 107a in the circumferential direction coincide at the lower section thereof with those of the holes 102a in the side plate 102 and the holes 106a in the inner plate 106. The notch 107a at the center of the segment 1 is perpendicular to the inner surface plate 101,

15 and the other notches 107a are oriented so as to be parallel to the notch 107a in the center. Such an arrangement facilitates removal from the mold when the segment is integrally formed.

 FIGS. 5a, 5b, and 5c show a method for linking the

20 segments 1 in the circumferential direction. Two segments 1, 1 are held so that the end plate 105 of one of the segments and the end plate 104 of the other segment are in contact with each other. A wrench or another tool, or a technician's finger, is inserted from the opening 102b in

25 the side plate 102 of the segment, and a bolt 6 is inserted into the insertion holes 104a, 105a. A nut 7 is then

threadedly engaged to the bolt 6, thereby tightening both end plates 104, 105 and linking the two segments 1, 1 in the circumferential direction. The concave section 104c and convex section 105c that fit into the concave section 104c
5 are formed on the end plate 104 and the end plate 105 at a position at which they intersect with the inner plate 107.

A concave section 104e and a convex section 104f are formed along the entire length in the pipe-length direction on a lower end of the end plate 104. A convex
10 section 105f and a concave section 105e that fit with the concave section 104e and the convex section 104f are formed along the entire length in the pipe-length direction on a lower end of the end plate 105. Such an arrangement facilitates the task of positioning the two segments 1 and
15 bringing the two segments in close contact with each other when the segments are linked in the circumferential direction. Also, applying a sealing material (not shown) to the fitting section makes it possible to enhance the watertightness of the linking section. Bolting as described
20 above is performed in two locations, i.e., between the side plate 102 and the adjacent inner plate 106, and between the side plate 103 and the adjacent inner plate 106. In an instance in which the linking in two locations as described above results in insufficient linking strength, a linking
25 member is also positioned in other insertion holes 104a, 105a, from above the segment, between the inner plates 106,

107 to strengthen the linking in the circumferential direction.

In FIG. 5a, one bolt/nut set is used per location. However, in an instance in which the end plates 104, 105
5 have a large height because of segments used for large-diameter existing pipes, the segments can be linked in the circumferential direction using two or more bolt/nut sets per location.

The segments are thus linked in the circumferential
10 direction through the openings 102b, 103b provided to the side plates 102, 103. When the segments are linked in the pipe-length direction so that the opening 102b of the segment is in alignment with the opening 103b of the adjacent segment and both the segments come in close contact
15 with each other, each set of the openings 102b, 103b forms a single integral opening. Therefore, when the filler material is injected into the spacing between the existing pipe and the rehabilitation pipe after installation of the rehabilitation pipe, the filler flows in or out through the
20 integrated openings 102b, 103b without flowing downwards towards the interior of the rehabilitation pipe. Therefore, there is no need to block the openings 102b, 103b, and linking in the circumferential direction can be performed in a simpler manner compared to an instance in which an opening
25 is provided to the inner surface plate 101.

By sequentially linking the segments 1 in the

circumferential direction around the full circumference, it is possible to assemble a closed ring-shaped short pipe assembly 10 (hereafter referred to as "pipe unit") having a predetermined small length in the pipe-length direction X as shown in FIG. 6. The pipe unit 10 has a shape that can be obtained when a circular pipe is sliced at a predetermined width D perpendicularly to the pipe-length direction X. The outside diameter of the pipe unit 10 is slightly smaller than the inside diameter of the existing pipe to be rehabilitated. The segment 1 corresponds to a member obtained by dividing the pipe unit 10 into a plurality of (preferably equal) portions along a cutting surface parallel to the radial direction R.

In FIG. 6, the inner surface plate 101, the side plates 102, 103, and the end plates 104, 105, which are the principal structural members of the segment 1, are shown. In order to prevent the drawing from becoming complicated, the inner plates 106, 107 and other reinforcement structures are not shown.

Each of the segments in the pipe unit 10 of such description is linked to a segment of another pipe unit using a linking member (tightening member) 11 and a nut 12 as shown in FIG. 7 for extension in the pipe-length direction.

The nut 12 is passed through a hole 102a in the side plate 102 of one segment 1a and brought into contact

with the first inner plate 106, i.e., the inner plate 106 positioned nearest to the side plate 102. A bolt 13 is threaded into the nut 12, and the nut 12 is tightened against the inner plate 106 and fixed against it.

5 The length of the nut 12 in the pipe-length direction is slightly greater than the spacing between the side plate 102 and the inner plate 106, and is such that the nut 12 protrudes outwards from the side plate 102 of the segment 1a when positioned as above. The amount of
10 protrusion is equivalent to or greater than the thickness of the side plate 103 of the other segment 1b. Therefore, the nut 12 is passed through the hole 103a in the side plate 103 of the other segment 1b, and the two segments 1a, 1b are placed against each other.

15 In this state, a linking member 11 is passed through a hole 102a in the side plate 102, a hole 106a in the inner plate 106, and a notch 107a in the inner plate 107 of the segment 1b, and a threaded section 11b of the linking member 11 is threaded into the nut 12 to link the linking
20 member 11 and the nut 12. The linking member 11 is further threaded into the nut 12 until a flange section 14a of a head section 14 presses against the leftmost inner plate 106 of the segment 1b to tighten and fix the two segments 1a, 1b.

 A plurality of the nuts 12 are fixed along the
25 circumferential direction to each segment, the nuts 12 being fixed to every second hole 102a, or at less regular

intervals, depending on the required strength. The segments are linked in the pipe-length direction with the nut positions in each segment being displaced in the circumferential direction relative to the nut positions in the segment adjacent to the segment in question. For example, in the example shown in FIG. 7, the positions of the nuts 12 in the segment 1a in the center is displaced relative to the positions of the nuts 12 in the segment 1c adjacent to the right side of the segment 1a by an amount corresponding to the intervals between the holes 102a in the side plate 102 as viewed in the circumferential direction.

Thus, the segments of the pipe unit are linked in the pipe-length direction to the segments of another pipe unit, whereby it is possible to link the pipe units in the pipe-length direction to a desired length, and to create a rehabilitation pipe comprising the pipe units or the segments.

A description will now be given for a method for rehabilitating an existing pipe using the segments configured as described above.

First, as shown in FIG. 8, the segment 1 is carried through a manhole 20 into an existing pipe 21, and as shown in FIGS. 5 and 6, the segments are sequentially linked in the circumferential direction to assemble the pipe unit 10.

Next, the pipe units 10 are sequentially linked in the pipe-length direction via the linking members 11 using

the method shown in FIG. 7, and as shown in FIGS. 8 and 9,
the rehabilitation pipe 40 is installed in the existing pipe
21. In FIGS. 8 and 9, the linking members 11 and similar
elements are not shown, and the segments are shown in a
5 simplified manner.

In FIGS. 7 through 9, the segments or the pipe
units are linked in the pipe-length direction such that the
segment and the segment adjacent thereto are offset to each
other in the circumferential direction and the end plates of
10 both the segments are out of alignment in the pipe-length
direction. Such an arrangement makes it possible to
automatically block the openings 102b, 103b of the side
plates 102, 103 by the side plates of the adjacent segment.
Therefore, there is no need to block the openings 102b, 103b,
15 and linking in the circumferential direction can be
performed in a simpler manner.

If the diameter of the rehabilitation pipe is large,
the segments 1 that have been carried in can be transported
to the location of actual installation, and the segments are
20 linked in the circumferential direction and the pipe-length
direction at this location. In such an instance, there may
be instances in which the gap between the outside of the
segments and the existing pipe is narrow when linking the
segments in the circumferential direction. This may
25 obstruct the mounting of bolt-and-nut sets from the outside
of the segment; the benefit of providing the side plates

with openings for linking the segments in the circumferential direction is particularly high.

Next, as shown in FIG. 9, a grout material or another filler material 30 is injected into a space S
5 between the rehabilitation pipe 40 and the existing pipe 21, and the filler material is hardened. Both end sections of the space S are blocked using a resin pate, mortar, or another sealing agent. For injection of the filler material, an injection hole is formed in, e.g., the inner surface
10 plate 101, and the filler material 30 is injected therefrom.

Injection is performed until the filler material 30 has reached the entirety of the rehabilitation pipe and has started to flow out from the side plates of segments on both ends in the pipe-length direction. During injection, the
15 filler material 30 don't flow out from the openings 102b, 103b of the side plates 102, 103 into the inside of the rehabilitation pipe 40. Such openings, therefore, improve the efficiency of the linking operation and the injection operation.

20 Since the notches 102c, 103c, 106b are respectively provided to the side plates 102, 103 and the inner plate 106 of the segment 1, the filler material can flow smoothly in the pipe-length direction even if the space S is small or if an obstacle is present in the space S. Also, since the
25 notches 102c, 103c formed in the side plate 102 or 103 and the notches 106b formed in the adjacent inner plate 106 are

staggered when the segment is viewed from above (outside), the filler material is injected in a zigzag shape, thus allowing the filler material to be injected in a uniform manner.

5 The height of the end plates 104, 105 is smaller than the height of the side plates 102, 103 and the inner plates 106, 107, and there is a significant gap between the upper end of the end plates 104, 105 and the existing pipe 21; therefore, the filler material can also flow smoothly in
10 the circumferential direction. The holes 104d, 105d provided to the lower section of the end plates 104, 105 not only allow the filler material to flow in or flow out and pass through, but also function as a passage for air between the existing pipe 21 and the inner surface plate 101 pushed
15 out when injecting the filler material, therefore allowing the filler material to flow in an even smoother manner.

 The injected filler material 30 allows the existing pipe 21 and the rehabilitation pipe 40 to be solidly bound when it is hardened, and it becomes possible to create a
20 composite pipe comprising the existing pipe, the filler material, and the rehabilitation pipe.

Claims :

1. A segment for a rehabilitation pipe, the segment comprising: an inner surface plate having an inner circumferential surface, and side plates and end plates provided upright on a peripheral edge of the inner surface plate; wherein the inner surface plate, the side plates, and the end plates are formed integrally from a plastic material and the segments are linked in a circumferential direction and in a pipe-length direction to install a segmental rehabilitation pipe inside an existing pipe; wherein each of the side plates is provided with at least one hole through which a linking member is inserted for linking the segments in the pipe-length direction, and is provided separately from the hole with an opening at an end in the vicinity of the end plate for a linking operation of the segments in the circumferential direction and for passing therethrough a filler material injected into a space between the existing pipe and the rehabilitation pipe, and wherein each of the end plates has at least one hole through which another linking member is inserted for linking the segments in the circumferential direction, the openings of the side plates being configured so that when the segments are connected in the circumferential direction, the another linking member is inserted through the at least one hole of each of the end plates and positioned and/or tightened through the openings of the side plates.
2. The segment for a rehabilitation pipe according to claim 1, wherein for each of the side plates, the opening is provided to each of both ends of the side plate.
3. The segment for a rehabilitation pipe according to claim 1, wherein for each of the side plates, a lower edge of the opening is proximate to a lower edge of the side plate, and an upper edge of the opening is lower than an upper edge of the side plate.
4. A pipe unit for a rehabilitation pipe used to rehabilitate an existing pipe, the pipe unit comprising a plurality of segments according to claim 1 mutually linked in a circumferential direction of the pipe unit.
5. A rehabilitation pipe for rehabilitating an existing pipe, the rehabilitating pipe comprising: a plurality of pipe units according to claim 4 mutually coupled together in a longitudinal direction of the existing pipe to assemble the rehabilitating pipe.
6. A pipe rehabilitation method for installing a rehabilitation pipe inside an existing pipe, the method comprising: providing a plurality of segments each comprised of an inner

surface plate having an inner circumferential surface, and side plates and end plates provided upright on a peripheral edge of the inner surface plate, each of the side plates being provided with at least one hole through which a linking member is inserted for linking the segments in a pipe-length direction, and being provided separately from the hole with an opening at an end in the vicinity of the end plate for a linking operation of the segments in the circumferential direction and for passing therethrough a filler material injected into a space between the existing pipe and the rehabilitation pipe, the inner surface plate, the side plates, and the end plates being formed integrally from a plastic material; bringing the end plates of the segments into contact with each other; inserting a linking member into through the openings provided to the side plates of each pair of adjacent segments whose end plates have been brought into contact with each other to sequentially link the segments in the circumferential direction, thereby forming a pipe unit; sequentially linking the pipe units in the pipe-length direction by inserting another linking member into the holes provided to the side plates of each pair of the adjacent segments to install a segmental rehabilitation pipe inside the existing pipe; and injecting a filler material into a space between the existing pipe and the rehabilitation pipe so that the filler material passes through the openings provided to the side plates of each pair of the adjacent segments.

7. The pipe rehabilitation method according to claim 6, wherein for each of the side plates of each segment, the opening is provided to each of both ends of the side plate.

8. The pipe rehabilitation method according to claim 6, wherein each of the end plates of each of the provided plurality of segments has at least one hole; wherein the end plates of the segments are brought into contact with each other so that the holes of the end plates are aligned with one another; and wherein the linking member is inserted through the openings provided to the side plates and positioned relative to the aligned holes of the end plates to link the segments in the circumferential direction.

9. The pipe rehabilitation method according to claim 6, wherein for each of the side plates of each of the provided plurality of segments, a lower edge of the opening substantially coincides with a lower edge of the side plate, and an upper edge of the opening is lower than an upper edge of the side plate.

10. In a pipe unit for a rehabilitation pipe used to rehabilitate an existing pipe, the pipe unit being formed of a plurality of segments mutually coupled together in a circumferential direction of the pipe unit, each of the segments comprising: an inner surface plate having a pair of opposite peripheral edges extending in a pipe-length direction of the rehabilitation pipe and a pair of opposite peripheral edges extending in the circumferential direction of the pipe unit; a pair of end plates provided upright on the respective peripheral edges of the inner surface plate extending in the pipe-length direction, each of the end plates having at least one hole through which a linking member is inserted for linking the segments together in the circumferential direction; and a pair of side plates provided upright on the respective peripheral edges of the inner surface plate extending in the circumferential direction, each of the side plates having an opening that is provided at an end thereof in the vicinity of one of the end plates and that is configured to provide access therethrough to the linking member when positioning and inserting the linking member through the holes of the end plates to sequentially link the segments together in the circumferential direction to form the pipe unit.

11. The pipe unit according to claim 10, wherein each of the side plates is provided with at least one hole different from the opening and through which another linking member is inserted for linking the segments in the pipe-length direction.

12. The pipe unit according to claim 11, wherein for each of the side plates, the opening is provided to each of both ends of the side plate and the at least one hole comprises a plurality of holes extending between the openings at both ends of the side plate.

13. The pipe unit according to claim 10, wherein for each of the side plates, the opening is provided to each of both ends of the side.

14. The pipe unit according to claim 10, wherein for each of the segments, the inner surface plate, the side plates and the end plates are formed integrally from a plastic material.

15. The pipe unit according to claim 10, wherein for each of the side plates of each of the segments, a lower edge of the opening substantially coincides with a lower edge of the side plate, and an upper edge of the opening is lower than an upper edge of the side plate.

16. The pipe unit according to claim 10, wherein for each of the side plates of each of the segments, the opening is configured for passing therethrough a filler material that is injected into a space between the existing pipe and the rehabilitation pipe.

- 5 17. A rehabilitation pipe for rehabilitating an existing pipe, the rehabilitating pipe comprising: a plurality of pipe units according to claim 10 mutually coupled together in a pipe-length direction of the existing pipe to assemble the rehabilitating pipe.