

Singapore

(11)

PATENT SPECIFICATION

(11) 1 509 790

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- (21) Application No. 51637/75 (22) Filed 17 Dec. 1975
- (31) Convention Application No. 603 646
- (32) Filed 11 Aug. 1975 in
- (33) United States of America (US)
- (44) Complete Specification published 4 May 1978
- (51) INT CL¹ F16L 13/02
- (52) Index at acceptance F2G 18B



(54) IMPROVEMENTS RELATING TO CONNECTING CONCRETE PIPE ELEMENTS

(71) We, NIPPON CONCRETE INDUSTRIES CO. LTD., a corporation organised under the laws of Japan, of 8-3, Shinbashi 1-chome, Minato-ku, Tokyo, Japan, do hereby declare the invention, for which we pray that a patent may be granted to us and the method by which it is to be performed, to be particularly described in and by the following statement:—

10 This invention relates to connecting concrete pipe elements.

In the transportation of long concrete pipes, the lengths of which are for example 25 m., 30 m. or more, to required places after they are manufactured in factories, various limitations exist. Therefore, short pipe sections are first separately manufactured, and after they are transported to a required place, they are connected in order to form a long concrete pipe before or as they are set in position.

25 The set pipe may be subjected to a large bending load as well as an axial load. A concrete pipe used as a post is generally subject to a horizontal bending load which is much larger than the axial load. For a longer concrete pipe, greater strength against bending is required.

30 Conventional structures for joining concrete pipe elements are shown in Figs. 1(A) and 2(A). In Fig. 1(A), a number of longitudinally extending reinforcements 11 are embedded within concrete pipe elements 13 fixed to end plates 12. Two adjacent end plates 12 are pushed against each other, and are secured together by a bead weld 14.

45 If the upper pipe section is subjected to a clockwise bending movement, the bead weld 14 is subjected to a load through the reinforcements 11 and the end plates 12 as shown in Fig. 1(B). In the drawing, reference numerals 11', 12' and 14' respectively designate each corresponding part on the assumption that reinforcement 11, end plate 12 and bead weld 14 are made of steel. Fig. 1(B) is a force diagram shown in a con-

venient way. As known from the drawing, the bead weld 14 is shown in the sectional view is subjected to considerable stress when the upper part or lower part of the concrete pipe is subjected to a bending force.

In Fig. 2(A), reinforcements 21 are not tensioned and end parts thereof are bent toward the outside. The ends of the reinforcements 21 are welded to the outer edges of end plates 22 of concrete pipe sections 23. This connection is relatively strong as known from the force diagram of Fig. 2(B). However this kind of connection cannot be applied to prestressed concrete pipes in which reinforcements are previously tensioned. Moreover the wire assembling operation is complicated.

This invention provides according to one aspect a concrete pipe comprising two concrete pipe elements placed end to end, longitudinal reinforcing members in each pipe element, an end plate mounted on the facing ends of each pipe element and attached to the reinforcing members, an annular recess which is formed between the two end plates and is co-axial with the pipe, and a split ring which is situated in the recess and is connected to the end plates.

Each pipe element will normally have longitudinal reinforcing members set in the concrete at a particular radial distance from the axis of the pipe, the longitudinal members being anchored to the end plates.

In one form of the invention where such reinforcing members are used the end plates are welded together at the deepest part of the aforementioned annular recess which is substantially as deep as that part of the reinforcing members which is at the greatest radial distance from the axis. This is considered to give a stronger structure than the known joining methods as will be described later with reference to Fig. 3(B). Alternatively the deepest part of the recess, where the weld is made between the end plates, may be radially inwardly of the

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reinforcing members, whilst the split ring is radially outwardly thereof. This also gives a strong structure as will be described with reference to Figs. 5(B) and 6(B).

5 In another form of the invention the end plates are connected together by a metal fitting positioned between them, the fitting comprising a cylinder coaxial with the pipe and two flanges which are welded to opposite ends of the cylinder and which lie against and are fixed to the said plates. The metal fitting serves to space apart the pipe elements thereby forming the annular recess between them. In this construction the cylinder preferably lies radially inwardly of the longitudinal reinforcing members and the split ring lies radially outwardly thereof. This is also considered to give a stronger structure than the known joining methods as will be described with reference to Fig. 4(B).

20 The invention will now be particularly described with reference to Figures 3 to 7 of the accompanying drawings, in which:—

25 Fig. 3(A) is a fragmentary sectional view of two connected pipe elements constituting a first embodiment of the present invention;

30 Fig. 3(B) is a force diagram showing the situation when a clockwise bending moment is given to the upper concrete pipe section of the embodiment shown in Fig. 3(A);

35 Fig. 4(A) is a fragmentary sectional view of two connected pipe elements constituting a second embodiment of the present invention;

40 Fig. 4(B) is a force diagram showing the situation when a clockwise bending moment is given to the upper concrete pipe section of the second embodiment;

45 Fig. 5(A) is a fragmentary sectional view of two connected pipe elements constituting a third embodiment of the present invention;

50 Fig. 5(B) is a force diagram showing the situation when a clockwise bending moment is given to the upper concrete pipe section of the third embodiment;

55 Fig. 6(A) is a fragmentary sectional view of two connected pipe elements constituting a fourth embodiment of the present invention;

60 Fig. 6(B) is a force diagram showing the situation when a clockwise bending moment is given to the upper concrete pipe section of the fourth embodiment;

65 Fig. 7 is a fragmentary sectional view of two connected pipe elements similar to those of the first embodiment shown in Fig. 3(A) but modified by the addition of a corrosion-proof material.

Fig. 3(A) is a fragmentary sectional view of two connected elements of a concrete pipe constituting the first embodiment of the present invention. Reference numerals 31 designate concrete pipe elements. Steel ring-shaped end plates 32 are attached to

end surfaces of the concrete pipe sections 31 and the shape of the end plates 32 is the same as that of the end of the pipe sections 31. The said end plates 32 are fixed to the ends of tensioned reinforcements 33 and non tensioned anchoring wires (which are not shown in the drawing) embedded within the pipe sections 31. Reference numerals 34 designate reinforcing steel bands which are welded to the end plates 32 and are attached on the outer peripheries of the end parts of the pipe elements 31.

As shown in the drawing, the end plate of one pipe element 31 is pushed against that of the other pipe element 31, and the two adjacent pipe elements 31 are welded together. The outer edges of the end plates 32 are chamfered to form a circular or annular recess in the form of a channel 35. The depth of the channel 35 is about equal to the depth of the tensioned reinforcements 33 from the outer surface of the concrete pipe. Welding is performed at the bottom of the annular channel 35 so that both end plates 32 are connected. Reference numeral 36 designates a bead weld at the bottom of the annular channel 35. The bead weld may be positioned on the pitch circle of the tensioned reinforcements 33 by making the depth of the annular channel 35 deeper.

Reference numeral 37 designates a segmented split ring fitting within the annular channel 35. The split ring is made of steel and welded to the chamfered surfaces of the end plates 32, and the bead welds 38 are formed.

The bead weld 36, directly connecting the end plates 32 is placed at or near the pitch circle of the tensioned longitudinal reinforcements 33. Therefore, if the upper or lower pipe element is subjected to a clockwise bending moment, the load is transmitted through the tensioned reinforcements 33 and the bead weld 36 in such a manner of a straight line as shown in Fig. 3(B), and further reinforcement against the said load is provided by the split ring 37 and the bead weld 38. Thereby, relatively high strength can be obtained against the bending moment given to either of the concrete pipe sections 31. Reference numerals 33' and 36' respectively denote the tensioned reinforcements 33 and the bead weld 36.

Fig. 4(A) is a fragmentary sectional view showing connected elements of the second embodiment of the present invention. In the drawing, reference numerals 41 designate concrete pipe elements. Within the concrete pipe elements 41 longitudinal reinforcements 32a and 42b are embedded. The ends of the reinforcements 42a and 42b are fixed to end plates 43. Reference numeral 46 designates a metal connecting fitting which consists of a cylinder 49 of a certain height, two annular or ring-shaped flanges 44 the

outer diameter of which is smaller than that of the concrete pipe section 41 and a number of radially arranged ribs 45. The cylinder 49 is welded to the inner edges of the flanges 44, and the ribs 45 are welded to the outer periphery of the cylinder 49.

The said metal connecting fitting 46 is inserted between the end plates 43 of the connected pipe elements 41. Each flange 44 and each end plate 43 are fastened with bolts 47 between adjacent ribs 45 and between the reinforcements 42a and 42b. In Fig. 4(A), the bolts 47 are protruding from the concrete, through the end plates 43 to the outside. However, it is also possible that bolt holes be made on the end plates 43, bolts being inserted from the side of the flanges 44 so as to perform the direct fastening. I-bolts may also be used.

The fitting 46 serves to space the pipe elements apart thereby forming an annular recess the base of which is defined by cylinder 49 and the walls of which are formed by end plates 43 in combination with flanges 44.

A segmented split ring 48 of cylinder shape the outer diameter of which is the same as that of the concrete pipe elements 41 is attached in the annular recess on a step formed by the outer periphery of the said metal fitting 46 between the end plates 43. The split ring 48 is welded to the end plates 43. Reference numerals 50 designate reinforcing bands attached on the outer periphery of the end parts of the concrete pipe elements and fixed to the end plates 43.

Fig. 4(B) is a force diagram of the situation when the upper pipe element is subjected to a clockwise bending moment. The end plates 43, the bolts 47, the metal fitting 46 and the split ring 48 constitute one steel body, and thereby the strength is increased.

Fig. 5(A) is a fragmentary sectional view showing connected parts of the third embodiment of the present invention. In this embodiment, ring-shaped end plates 53 are attached to the ends of concrete pipe element 51, and reinforcements 52 are fixed to the plates 53. One end plate 53 has a cylindrical downward projection 54 at the inner edge. The other end plate 53 has a cylindrical guide projection 58 at the inner edge. The outer surface of the guide projection 58 is in contact with the inner surface of the downward projection 54.

The downward projection 54 of one end plate 53 is in contact with the upper surface of the other end plate 53 and is welded thereto at the contact corner. Reference numeral 53 designates a cylindrical split ring the outer diameter of which is the same as that of the concrete pipe sections 51. The split ring 55 is inserted into the annular

recess formed between the end plates 53 and welded to the end plates 53.

Reference numerals 56 designate anchoring wires for reinforcing the connection of the end plates 53 to the concrete pipe elements 51, and 57 designate reinforcing bands of steel plate having a number of projections on the surface. The reinforcing bands 57 are generally called checker plates and are welded to the end plates 53.

Fig. 6(A) is a fragmentary sectional view showing connected parts of the fourth embodiment of the present invention. This embodiment is a little different from the third embodiment. Ring-shaped end plates 63, fixed to the ends of concrete pipe elements 61, have an angular cross-section, i.e. the end plates have cylindrical projections 64 of the same diameter at their inner edges. Therefore, the adjacent projections 64 are pushed against and abut each other. Ends of reinforcements 62 are fixed to the end plates 63. A cylindrical guide 68 is provided in such a manner that it is in contact with the inner surface of the joined parts of the said projections 64 and welded to either of the projections 64. The projections 64 are welded to each other on the outer periphery thereof. A cylindrical split ring 65, the outer diameter of which is the same as that of the concrete pipe sections 61, is inserted into an annular recess formed between the end plates 63 and is welded to the end plates.

If the upper pipe sections 61 of the third and fourth embodiments are subjected to a clockwise bending moment, the loads are transmitted respectively as shown in Figs. 5(B) and 6(B). In the third and fourth embodiments, since the end plates, the cylindrical projections and a split ring constitute one steel body, relatively strong connection similar to the second embodiment can be obtained.

Fig. 7 is a fragmentary sectional view of the connected parts of an embodiment similar to that of Fig. 3(A) but modified to prevent corrosion. The outer diameter of the end parts 39 of the concrete pipe sections 31 is smaller than that of the rest of the pipe sections 31 by a certain dimension. A waterproof layer 40 is provided by charging the said end parts 39 with synthetic resin or another watertight material such as mortar so that the connected parts are not exposed. The waterproof layer 40 may be formed by a band of for example synthetic resin.

The formation of the above-mentioned waterproof layer 40 is not limited to the first embodiment, but can be also applied to the second, third and fourth embodiments.

The waterproof layer 40 is effective to prevent the corrosion of connected parts under the ground. Moreover, in case

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connected parts are positioned above the ground, there is the advantage that a good appearance is obtained.

The present invention can be applied to many different types of reinforced concrete pipe. It is most important to note that this includes a concrete pipe reinforced by pre-stressed members.

WHAT WE CLAIM IS:—

1. A concrete pipe comprising two concrete pipe elements placed end to end, longitudinal reinforcing members in each pipe element, an end plate mounted on the facing ends of each pipe element and attached to the respective reinforcing members, an annular recess which is formed between the two end plates and is co-axial with the pipe, and a split ring which is situated in the recess and is connected to the end plates.

2. A concrete pipe according to claim 1 in which opposite sides of the split ring are welded to the plates.

3. A concrete pipe according to claims 1 or 2 in which an outside surface of the split ring lies level with the outside surfaces of the pipes.

4. A concrete pipe according to any preceding claim in which each end plate is ring-shaped and has an inner diameter which is the same as that of both the pipes.

5. A concrete pipe according to any preceding claim in which the longitudinal reinforcing members are all set in the concrete at the same radial distance from the axis of the pipe.

6. A concrete pipe according to any preceding claim in which each end plate is welded to a reinforcing band extending around the pipe element.

7. A concrete pipe according to claim 5 in which the deepest part of the recess is substantially in alignment with the longitudinal reinforcing members.

8. A concrete pipe according to any preceding claim in which the end plates bear against each other and the recess is formed between bevelled edges of the end plates.

9. A concrete pipe according to claim 8 in which the plates are welded together at the deepest part of the recess.

10. A concrete pipe according to any preceding claim in which each end plate is ring-shaped and has an outer diameter which is the same as that of both the pipes.

11. A concrete pipe according to any of claims 1 to 9 in which the outer diameter of each plate is less than the outer diameter of the pipes thereby leaving a space which is fitted with water-tight material.

12. A concrete pipe according to claim 11 when dependent on claim 7 in which the water-tight material also covers the reinforcing bands.

13. A concrete pipe according to any one

of claims 1 to 6 in which the end plates are connected together by a metal fitting positioned between them, the fitting comprising a cylinder co-axial with the pipe and two flanges which are welded to opposite ends of the cylinder and which lie against and are fixed to the said plates, the metal fitting serving to space apart the pipe elements thereby forming the annular recess between them.

14. A concrete pipe according to claim 13 when dependent on claim 5 in which the cylinder lies radially inwardly of the longitudinal reinforcing members and in which the split ring lies radially outwardly thereof.

15. A concrete pipe according to claim 14 in which the split ring lies against peripheral edges of the flanges.

16. A concrete pipe according to claim 14 in which the split ring is cylindrical and has an outer diameter substantially equal to the outer diameters of the pipe elements; the outer diameters of the pipe elements being equal to each other.

17. A concrete pipe according to claim 13, 14, 15 or 16 in which the flanges are bolted to the end plates.

18. A concrete pipe according to any of claims 13 to 17 in which the flanges are ring-shaped and have an inner diameter substantially equal to the inner diameters of the pipe elements; the inner diameters of the pipe elements being equal to each other.

19. A concrete pipe according to any of claims 1 to 6 in which the end plates are ring-shaped and one end plate has a first cylindrical projection at an inner edge thereof, this projection being welded to the other end plate and serving to form a space between the plates, which space constitutes the said annular recess.

20. A concrete pipe according to claim 19 in which the other end plate has a second cylindrical projection at an inner edge thereof this second projection fitting radially inside the first projection.

21. A concrete pipe according to claim 19 in which the other end plate has a second cylindrical projection at an inner edge thereof this second cylindrical projection abutting the first projection.

22. Parts for assembly to form a concrete pipe comprising: two pipe elements each having an end plate, longitudinal reinforcing members set in the concrete of each pipe element at a particular radial distance from the axis thereof, the reinforcing members being attached to the respective plates and the end plates being bevelled at their edges so that, when the pipe elements are placed end to end, an annular channel is formed between the bevels, the deepest part of this channel being substantially as deep as that part of the reinforcing members which is at

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connected parts are positioned above the ground, there is the advantage that a good appearance is obtained.

- 5 The present invention can be applied to many different types of reinforced concrete pipe. It is most important to note that this includes a concrete pipe reinforced by pre-stressed members.

WHAT WE CLAIM IS:—

- 10 1. A concrete pipe comprising two concrete pipe elements placed end to end, longitudinal reinforcing members in each pipe element, an end plate mounted on the facing ends of each pipe element and attached to the respective reinforcing members, an annular recess which is formed between the two end plates and is co-axial with the pipe, and a split ring which is situated in the recess and is connected to the end plates.
- 20 2. A concrete pipe according to claim 1 in which opposite sides of the split ring are welded to the plates.
3. A concrete pipe according to claims 1 or 2 in which an outside surface of the split ring lies level with the outside surfaces of the pipes.
4. A concrete pipe according to any preceding claim in which each end plate is ring-shaped and has an inner diameter which is the same as that of both the pipes.
- 30 5. A concrete pipe according to any preceding claim in which the longitudinal reinforcing members are all set in the concrete at the same radial distance from the axis of the pipe.
6. A concrete pipe according to any preceding claim in which each end plate is welded to a reinforcing band extending around the pipe element.
- 40 7. A concrete pipe according to claim 5 in which the deepest part of the recess is substantially in alignment with the longitudinal reinforcing members.
- 45 8. A concrete pipe according to any preceding claim in which the end plates bear against each other and the recess is formed between bevelled edges of the end plates.
9. A concrete pipe according to claim 8 in which the plates are welded together at the deepest part of the recess.
- 50 10. A concrete pipe according to any preceding claim in which each end plate is ring-shaped and has an outer diameter which is the same as that of both the pipes.
- 55 11. A concrete pipe according to any of claims 1 to 9 in which the outer diameter of each plate is less than the outer diameter of the pipes thereby leaving a space which is fitted with water-tight material.
12. A concrete pipe according to claim 11 when dependent on claim 7 in which the water-tight material also covers the reinforcing bands.
- 65 13. A concrete pipe according to any one

of claims 1 to 6 in which the end plates are connected together by a metal fitting positioned between them, the fitting comprising a cylinder co-axial with the pipe and two flanges which are welded to opposite ends of the cylinder and which lie against and are fixed to the said plates, the metal fitting serving to space apart the pipe elements thereby forming the annular recess between them.

14. A concrete pipe according to claim 13 when dependent on claim 5 in which the cylinder lies radially inwardly of the longitudinal reinforcing members and in which the split ring lies radially outwardly thereof.

15. A concrete pipe according to claim 14 in which the split ring lies against peripheral edges of the flanges.

16. A concrete pipe according to claim 14 in which the split ring is cylindrical and has an outer diameter substantially equal to the outer diameters of the pipe elements; the outer diameters of the pipe elements being equal to each other.

17. A concrete pipe according to claim 13, 14, 15 or 16 in which the flanges are bolted to the end plates.

18. A concrete pipe according to any of claims 13 to 17 in which the flanges are ring-shaped and have an inner diameter substantially equal to the inner diameters of the pipe elements; the inner diameters of the pipe elements being equal to each other.

19. A concrete pipe according to any of claims 1 to 6 in which the end plates are ring-shaped and one end plate has a first cylindrical projection at an inner edge thereof, this projection being welded to the other end plate and serving to form a space between the plates, which space constitutes the said annular recess.

20. A concrete pipe according to claim 19 in which the other end plate has a second cylindrical projection at an inner edge thereof this second projection fitting radially inside the first projection.

21. A concrete pipe according to claim 19 in which the other end plate has a second cylindrical projection at an inner edge thereof this second cylindrical projection abutting the first projection.

22. Parts for assembly to form a concrete pipe comprising: two pipe elements each having an end plate, longitudinal reinforcing members set in the concrete of each pipe element at a particular radial distance from the axis thereof, the reinforcing members being attached to the respective plates and the end plates being bevelled at their edges so that, when the pipe elements are placed end to end, an annular channel is formed between the bevels, the deepest part of this channel being substantially as deep as that part of the reinforcing members which is at

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the greatest radial distance from the axis; and a split ring adapted to fit into the channel where it can be welded to both end plates.

5 23. Parts for assembly to form a concrete pipe comprising: two pipe elements each having an end plate, longitudinal reinforcing members set in the concrete of each pipe element at a particular radial distance from the axis thereof, the reinforcing members being attached to the respective end plates; a metal fitting adapted to fit between the pipe elements to connect the latter end to end, the said fitting comprising a cylindrical part whose radius is less than the said radial distance, and a pair of annular flanges at opposite ends of the cylindrical part, the outer edges of the flanges having a radius greater than the said radial distance but less than the outer radius of the pipe elements; and a split ring adapted to fit against the said outer edges.

24. Parts for assembly to form a concrete pipe comprising: two pipe elements each having an end plate, longitudinal reinforcing members set in the concrete of each pipe element at a particular radial distance from the axis thereof, the reinforcing members

being attached to the respective end plates and the end plates being shaped so that, when the pipe elements are placed end to end an annular channel is formed between the end plates, the deepest part of this channel having a radius less than the said radial distance; and a split ring whose radius is greater than the said radial distance and which is adapted to fit into the channel where it can be welded to both plates.

25. A concrete pipe substantially as described herein with reference to Figures 3A and 3B or Figures 4A and 4B or Figures 5A and 5B or Figures 6A and 6B or Figure 7 of the accompanying drawings.

26. A method of joining two concrete pipe elements together substantially as described herein with reference to Figures 3A and 3B or Figures 4A and 4B or Figures 5A and 5B or Figures 6A and 6B or Figure 7 of the accompanying drawings.

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Printed for Her Majesty's Stationery Office by the Courier Press, Leamington Spa, 1978.
Published by the Patent Office, 25 Southampton Buildings, London, WC2A 1AY, from which copies may be obtained.

