What is claimed is:

1. A reinforcement structure for reinforcing an underwater structure having an embedment type rigid-frame structure including a plurality of steel pipe piles and a superstructure work that connects head portions of the steel pipe piles, the reinforcement structure comprising:

a casing pipe that has an inside diameter greater than an outside diameter of the steel pipe pile and has a structure divided into two or more parts in a peripheral direction surrounding the steel pipe pile;

rubber tubes that are provided in the casing pipe and block openings of a gap formed at end portions in an insertion direction of the steel pipe pile and the casing pipe by expanding as a fluid is injected into the rubber tubes;

a brace member that is extensible and reinforces the underwater structure, end portion of the brace member being connected to the casing pipe; and

a grout material that fills the gap between the steel pipe pile and the casing pipe in a state where the steel pipe pile is inserted through the casing pipe as a connection member that joins the brace member to the steel pipe pile,

wherein at least one of the two or more parts of the casing pipe is connected to the end portion of the brace member in advance before the brace member is joined to the steel pipe pile.

2. The reinforcement structure according to claim 1, wherein an end portion of the brace member is connected to be rotatable with respect to the casing pipe.

3. The reinforcement structure according to claim 1 or 2, wherein the brace member is a tie rod.

4. A reinforcement method for reinforcing an underwater structure having an embedment type rigid-frame structure including a plurality of steel pipe piles and a superstructure work that connects head portions of the steel pipe piles, the reinforcement method comprising the steps of:

providing rubber tubes at end portions in an insertion direction of the steel pipe pile into a casing pipe that has an inside diameter greater than an outside diameter of the steel pipe pile and has a structure divided into two or more parts in a peripheral direction surrounding the steel pipe pile, a brace member that is extensible being connected to the casing pipe;

inserting the steel pipe pile into the casing pipe;

injecting a fluid into the rubber tubes, after inserting the steel pipe pile into the casing pipes, to expand the rubber tubes, thereby blocking openings of a gap formed at the end portions in the insertion direction of the steel pipe pile and the casing pipe; and

filling the gap between the steel pipe pile and the casing pipe with a grout material, thereby joining the brace member to the steel pipe pile.

5 The reinforcement method according to claim 4, wherein, after one casing pipe of the casing pipes respectively provided at both ends of the brace members is mounted to the steel pipe pile, the one casing pipe is moved downward along the steel pipe pile, and thereafter the other casing pipe is mounted to the other steel pipe pile.

6. The reinforcement method according to claim 4 or 5, wherein the end portion of the brace member is connected to be rotatable with respect to the casing pipe.

7. The reinforcement method according to any one of claims 4 to 6, wherein the brace member is a tie rod.