

DEMOLISHING METHOD

TECHNICAL FIELD OF THE INVENTION

[0001]

This invention relates to a demolishing method for demolishing a concrete member.

BACKGROUND OF THE INVENTION

[0002]

In recently increasing large-scaled constructions for redevelopment of urban areas, in order to build a new structure such as a large-scaled underground structure, it is sometimes necessary to locally demolish a large-sized concrete member, such as a pressure resistant plate, of a pre-existing underground structure.

[0003]

FIG. 19 (a) is an example of a pre-existing structure 103 including a pressure resistant plate 105, which is a large-sized concrete member. In order to build a new structure under this pre-existing structure 103, firstly, the periphery of the pressure resistant plate 105 is demolished and removed as shown in FIG. 19 (b), and earth retaining walls 107 are provided under the demolished parts in a ground 101. Then, as shown in FIG. 19 (c), the remaining parts of the pressure resistant plate 105 are demolished and removed, and the ground 101 within the earth retaining walls 107 is excavated. After that, a structure is built at the excavated part.

[0004]

As a way of demolishing concrete members, heavy machines for demolishing such as breakers, which break the members by knocking, or similar apparatus are often used. However, breaking by knocking creates problems of noise and vibration.

[0005]

As a demolishing method with less noise and vibration, there is a method in which a hydraulic crusher (nibbler) of which claws interpose and crush concrete members is used. Alternatively, if the construction site is too small for the use of a large-sized heavy machine, a method in which concrete members are cut by sequential core boring is often used. In this method, members are cut by a plurality of sequential boring holes to make the concrete member into sizes that can be lifted up and taken out.

[0006]

Moreover, there is also a method for splitting a concrete member in which hydraulic breaker or expansive fracturing agent is inserted into holes provided in the concrete member to apply pressure to the member and generate cracks (Patent Document 1 to 3, for example).

[0007]

Also, there is also a method known as a CD method in which a large-sized casing is rotated for the whole circumference to cut a concrete member into a circular shape, which is then taken out by a hammer grab attached to an external crawler crane to be demolished.

[0008]

Also, in case of demolishing a large-sized concrete member such as a wall body of a pre-existing underground structure, usually, a large-sized heavy machine such as a giant breaker is used to demolish the concrete member from top to bottom.

[0009]

Moreover, as a method for demolishing concrete members, demolishing by blasting explosives used in conventional construction works may also be considered (See Patent Document 4).

RELATED ART

PATENT DOCUMENTS

[0010]

[Patent Document 1] Japanese Unexamined Patent Application Publication No.2003-90316 (JP-A-2003-90316)

[Patent Document 2] Japanese Unexamined Patent Application Publication No. H07-324585 (JP-A- H07-324585)

[Patent Document 3] Japanese Unexamined Patent Application Publication No. S61-155589 (JP-A- S61-155589)

[Patent Document 4] Japanese Unexamined Patent Application Publication No.2009-228977 (JP-A-2009-228977)

SUMMARY OF THE INVENTION

(PROBLEMS TO BE SOLVED BY THE INVENTION)

[0011]

In the case of demolishing a pressure resistant plate of a pre-existing structure as mentioned above, demolishing by knocking requires great force since the

periphery of the pressure resistant plate is restrained. For this reason, it is preferable to use a large-sized heavy machine. However, if the demolishing takes place in a small space inside the pre-existing structure, there is no choice but to use a small-sized heavy machine, which impairs demolishing efficiency extremely.

[0012]

Also, the demolishing method with nibblers requires forming of many boreholes in the member for inserting the claw parts, which results in increase in construction period and cost. The demolishing method with sequential core boring also requires forming of many boreholes in the member, causing similar problems.

[0013]

Splitting concrete members by applying pressure has less of such problems. However, in the conventional method, since an area of a member within straight lines joining many holes is broken at one time, large applied pressure is required to demolish a member of which the periphery is restrained. The large applied pressure creates problems such as scattering of the broken member out of the plane. Also, if breaking of the concrete member and removal of its debris are repeated alternately, swapping of the heavy machines tends to take place too often that demolishing efficiency is impaired.

[0014]

The CD method is costly since the main body of the machine that rotates the casing for the whole circumference and the crawler crane are large-sized. Also, it is inefficient because the operation of the main body takes place mainly on the pre-existing construction and it is necessary to reinforce the pre-existing construction since the machine is large-sized.

[0015]

Also, if a large-sized heavy machine such as a giant breaker is used to demolish a wall body, there have been problems of large noise and vibrations. Also, it requires a space to place the large-sized heavy machine at the time of demolishing and cannot be applied for a small space operation.

[0016]

Similarly, demolishing by blasting also has problems of noise and vibration. Particularly, in cases in which the wall body is surrounded and restrained by columns and beams, many perforations and charging of explosives are required and the problems of noise and vibration are too serious that it is difficult to be applied to building constructions in urban areas.

[0017]

The method in which hydraulic breakers and the like are inserted into holes and pressure is applied to concrete by them to generate cracks can be operated easily even in small spaces with less noise and vibration. However, caution should be taken in demolishing a wall body. For example, if concrete is split by applying pressure thereto by hydraulic breakers that pushes up the concrete to generate cracks, the split concrete may subside due to its own weight to block the cracks, making it difficult for the secondary breaking of the concrete by nibblers and the like or preventing the hydraulic breakers from being taken out because of the pressure of the subsided concrete.

[0018]

Embodiments of the present invention seek to provide solutions to such problems and to provide a demolishing method that can demolish a concrete member ideally.

(MEANS FOR SOLVING PROBLEMS)

[0019]

A first aspect of the present invention is a demolishing method for demolishing a concrete member. The method comprises a step (a) of forming opening sections at intervals in a planned demolishing region of the concrete member and a step (b) of splitting the concrete member by applying pressure using a hydraulic breaker from fracturing holes perforated at intermediate regions between the opening sections of the concrete member to push the concrete member toward the opening sections, thereby splitting the concrete member. The step (b) is repeated so that the concrete member at the intermediate regions is split from each side of the opening sections sequentially.

[0020]

According to embodiments in the present invention, the opening sections are formed at intervals first, and then the concrete member is broken by splitting the concrete member at the intermediate regions between the opening sections. On this occasion, the step of splitting the concrete member by applying pressure from the fracturing holes perforated at appropriate positions to push out the concrete member toward the opening sections is repeated so to carry out the splitting sequentially from each side of the opening sections. This method requires no large-sized heavy machines and less number of perforations so that the operation is easy with reduced cost and work period. Also, this method can be applied for operations in small underground spaces and has less problems of noise and vibration. Furthermore, compared to the conventional method in which a member in the region inside straight lines joining many holes is broken at one time, the concrete member can be split with less

applying pressure so that problems such as scattering of the member does not occur. Furthermore, the number of times of swapping of the heavy machines and the like can be reduced and the demolishing efficiency is high.

[0021]

In the step (b), it is preferred to apply pressure to the concrete member using a hydraulic breaker.

By using a hydraulic breaker, pressure can be applied in a predetermined direction so that the concrete member can be pushed out toward an intended direction, preventing unnecessary cracks to be created in the surrounding concrete member and allowing to control the breaking easily.

[0022]

In the step (a), it is preferred that sequential core holes, in which a plurality of core holes are in sequence, are formed, the concrete member is pushed out from the fracturing holes that are perforated on the periphery of the sequential core holes toward the sequential core holes to be split, and the split concrete member is removed.

This is preferable because, in this case, common heavy machines and the like can be used for forming the opening sections and splitting the intermediate regions.

[0023]

It is also preferable that, in the step (a), the concrete member is pushed out from the fracturing holes perforated obliquely in a vertical plane toward a surface of the concrete member to be split and then the split concrete member is removed.

This case has an advantage that there is no need to perforate the concrete member beforehand to secure a space for movement of the concrete member since the concrete member is split by being pushed out toward the surface thereof.

[0024]

Also, in the step (a), it is preferable to perforate a core hole having a diameter ranging the overall width of the planned demolishing region.

This case has an advantage that the opening section can be formed by perforating only one core hole.

[0025]

Also, in the step (a), it is preferable to perforate a core hole having a diameter smaller than the overall width of the planned demolishing region, to push out the concrete member from the fracturing holes that are perforated on both edge parts of the planned demolishing region in its width direction toward the core hole to be

split, and to remove the split concrete member.

In this case, there are advantages that the number of times of perforations is less and the width of the opening sections can be set variously.

[0026]

In the step (a), it is also preferable to form sequential core holes in which a plurality of core holes are in sequence ranging the overall width of the planned demolishing region.

This has an advantage that a narrow opening section can be formed.

[0027]

It is preferred that the concrete member is a pressure resistant plate of a structure.

When demolishing such a structure, the operation is carried out in a small space and the periphery of the planned demolishing region is restrained. Therefore, effects of demolishing by using the demolishing method according to embodiments of the present invention are especially high.

[0028]

A second aspect of the present invention is a demolishing method comprising a step (a) of forming a groove at a lower part of a planned demolishing region of a plate-like concrete member of vertical plane direction along a width direction of the planned demolishing region and a step (b) of splitting the concrete member by applying pressure in upper and lower directions from fracturing holes perforated above the groove using hydraulic breaker to push the concrete member in a downward direction toward to groove, thereby splitting the concrete member. The step (b) is repeated so that the concrete member of the planned demolishing region is split sequentially from the lower part to an upper part of the planned demolishing region.

[0029] According to the second aspect, a plate-like concrete member of vertical plane direction such as a wall body can be demolished without using large-sized heavy machines and with only small number of perforations. Also, since the concrete member is pushed out downward and split by applying pressure from the fracturing holes above the groove, the split concrete member subsides due to its own weight to widen the cracks. This facilitates secondary breaking by nibblers and the like, prevents the hydraulic breakers from getting stuck, and, therefore, improves operability. Also, by using the hydraulic breakers to break the concrete member, the concrete member can be pushed out toward an intended direction, preventing unnecessary cracks to be created in the surrounding concrete member and allowing to control the breaking easily.

[0030]

It is preferred that the concrete member is an underground wall that is joined to an underground column or an underground beam and the underground column or the underground beam is demolished after demolishing the planned demolishing region of the underground wall.

Demolishing the planned demolishing region of the underground wall first enables to demolish the underground column or the underground beam utilizing the space originally occupied by the underground wall, which improves the operability of demolishing work of the underground structure.

[0031]

It is preferred that the underground column or the underground beam is demolished after demolishing the planned demolishing region of the underground wall and removing the ground behind the underground wall.

Demolishing the underground wall enables to remove the ground behind, and demolishing the underground column or the underground beam utilizing the space made after removing the ground improves the operability of demolishing work of the underground structure.

(EFFECTS OF THE INVENTION)

[0032]

The present invention can provide a demolishing method that can demolish a concrete member ideally.

BRIEF DESCRIPTION OF DRAWINGS

[0033]

FIG. 1 is a perspective view showing a demolishing method.

FIG. 2 is a plan view of a region around an opening section.

FIG. 3 illustrates a hydraulic breaker 15.

FIG. 4 is a plan view of a planned demolishing region 3.

FIG. 5 is a plan view of a planned demolishing region 3.

FIG. 6 shows fracturing holes 33 in the opening section region.

FIG. 7 illustrates a hydraulic breaker 37.

FIG. 8 illustrates the splitting of a concrete member at the opening section region.

FIG. 9 illustrates forming of an opening section 5.

FIG. 10 illustrates forming of the opening section 5.

FIG. 11 illustrates forming of the opening section 5.

FIG. 12 shows an underground structure 71.
FIG. 13 shows demolishing of a wall 73.
FIG. 14 shows demolishing of the wall 73.
FIG. 15 shows the hydraulic breakers 15 and 37.
FIG. 16 shows a split concrete member.
FIG. 17 shows demolishing of a column 75 and a beam 77.
FIG. 18 shows demolishing of the column 75.
FIG. 19 shows an example of a pre-existing structure 103.

DESCRIPTION OF SOME EMBODIMENTS

[0034]

Hereinafter, some embodiments of the present invention will be described with reference to the accompanying drawings.

[0035]

(First Embodiment)

(1. Outline of a demolishing method)

First, an outline of a demolishing method according to a first embodiment of the present invention will be described. Here, a periphery of the pressure resistant plate 105, which is a large-sized concrete member described in FIG. 19, will be demolished in belt-like shape.

[0036]

In the present embodiment, within a belt-like planned demolishing region 3 of the pressure resistant plate 105 shown in FIG. 1 (a), firstly, as shown in FIG. 1 (b), diamond-shaped rectangular planar opening sections 5 ranging the overall width of the planned demolishing region 3 are formed at predetermined intervals 7 in a lengthwise direction of the planned demolishing region 3.

[0037]

For example, if a thickness of the pressure resistant plate 105 is 650 mm and a width 9 of the planned demolishing region 3 is approximately 1 m, the interval 7 of the opening sections 5 is set to be approximately 5 m and a breadth 8 of the opening 5 is set to be in a range approximately between 0.5 m and 1 m.

[0038]

Then, the concrete member at intermediate regions 13 between adjacent opening sections 5 are split and broken sequentially from each side of the opening sections 5 into debris 14 as shown in FIG. 1 (c). After the debris 14 is removed, demolishing of the planned demolishing region 3 is completed as shown in FIG. 1 (d).

[0039]

Next, the formation of the opening sections 5 and splitting of the concrete member at the intermediate regions 13 mentioned above will be described.

[0040]

(2. Formation of the opening sections 5)

First, formation of the opening sections 5 will be described with reference to FIG. 2. FIG. 2 is a plan view of a vicinity of a region in which an opening section 5 is formed (hereinafter, called as an opening section region).

[0041]

In the present embodiment, as shown in FIG. 2 (a), sequential core holes 19 are formed at the center part of the opening section region, and, in addition, a plurality of fracturing holes 21 are formed around the sequential core holes 19.

[0042]

The sequential holes 19 are formed by perforating a sequence of a plurality of core holes in the planned demolishing region 3 of the lengthwise direction (corresponding to the horizontal direction in the drawing, hereinafter called as a region-lengthwise direction). The fracturing holes 21 are perforated on both edge parts of the planned demolishing region 3 in its width direction (corresponding to the vertical direction in the drawing, hereinafter called as a region-width direction). The fracturing holes 21 are formed on the sides of the sequential core holes 19 in the region-width direction. The above-mentioned core holes and the fracturing holes 21 are perforated by core boring or rock drilling, penetrating the pressure resistant plate 105 in its thickness direction. The diameter of one hole is approximately 100 mm, which is not limited thereto.

[0043]

Then, the concrete member at the opening section region is split by using a hydraulic breaker. The hydraulic breaker creates cracks in the concrete member by applying pressure thereto so to split and break the concrete member.

[0044]

FIG. 3 (a) is an example of a hydraulic breaker 15. As shown in the left side drawing of FIG. 3 (a), a wedge liner 17, which is a tip part of the hydraulic breaker 15, is inserted into a fracturing hole 21, and, as shown in the right side drawing of FIG. 3 (a), a wedge-shaped wedge 18 is pushed in by hydraulic pressure to expand the wedge liner 17 to both sides. Then, pressure can be applied to the concrete member through the fracturing hole 21.

[0045]

As shown in the left side drawing of FIG. 3 (b), inserting the hydraulic breaker 15 into the fracturing hole 21 on the side of the sequential core holes 19 and expanding the wedge liner 17 in a direction that joins the fracturing hole 21 and the sequential core holes 19 add pressure to the concrete member between the fracturing hole 21 and the sequential core holes 19. Then, the concrete member is pushed out toward the sequential core holes 19 shown by an arrow and, as shown in the right side drawing of FIG. 3 (b), the concrete member is split at splitting faces 23 that join the fracturing hole 21 and both end parts of the sequential core holes 19.

[0046]

When the edge liner 17 is expanded, there is a pressure added from the fracturing hole 21 in the direction opposite to the direction toward the sequential core holes 19. However, there is no sequential core hole 19 (a free area) on this side for the concrete member to move, and the pressure from the wedge liner 17 solely acts as the force pushing the concrete member only toward the sequential core holes 19.

[0047]

In the present embodiment, the hydraulic breaker 15 is inserted into the fracturing hole 21 shown in FIG. 2 (a). And, as described above, the concrete member between each of the fracturing holes 21 and the sequential core holes 19 are pushed out in the direction toward the sequential core holes 19 shown by the arrows as shown in FIG. 2 (b). This splits the concrete member as shown in FIG. 2 (c) and the splitting faces 23 are formed between each of the above-mentioned fracturing holes 21 and the both end parts in the region lengthwise direction of the sequential core holes 19.

[0048]

The debris of the concrete member produced after splitting and breaking as above is secondly broken by rippers and the like into sizes that are easily removable, and then the debris is removed completely by using bucket and the like. The ripper breaks concrete members by vertically vibrating a tip tooth thereof that is inserted into a gap and the like of the concrete member. In this way, the opening section 5 is formed as shown in FIG. 2 (d), which is a state shown in FIG. 1 (b).

[0049]

(3. Splitting the concrete member at the intermediate region 13)

Next, splitting of the concrete member at the intermediate region 13 between the opening sections 5 will be described with reference to FIG. 4 and FIG. 5. FIG. 4

and FIG. 5 are plan views of the planned demolishing region 3.

[0050]

In the present embodiment, as shown in FIG. 4 (a), fracturing holes 25 are perforated at both end parts in the region width direction of the planned demolishing region 3 on both sides of each of the opening sections 5 in the region lengthwise direction.

[0051]

Next, the hydraulic breaker 15 is inserted into the fracturing holes 25, and the concrete member between the fracturing hole 25 and the opening section 5 is pushed out in the direction toward the opening section 5, shown by the arrow. This splits the concrete member as shown in FIG. 4 (b) and splitting faces 27 are formed between the fracturing hole 25 and both end parts of a side of the opening section 5 that faces the fracturing hole 25.

[0052]

Then, as shown in FIG. 4 (c), new fracturing holes 25 are provided on both sides of the opening 5 in the region lengthwise direction at the center parts of the planned demolishing region 3 in the region width direction. These fracturing holes 25 are perforated with a predetermined interval of perforation from the opening section 5. The interval of perforation may be, for example, approximately between 400 mm and 600 mm, which is approximately half of the width of the planned demolishing region 3.

[0053]

Then, the hydraulic breaker 15 is inserted into these new fracturing holes 25, and the concrete member between each of the fracturing holes 25 and the splitting faces 27 facing thereof is pushed out to the direction of the opening section 5, which is shown by the arrow. This splits the concrete member and forms the new splitting faces 27 between the new fracturing holes 25 and the fracturing holes 25 on both edge parts in the region width direction as shown in FIG. 4 (d). Pushing out the concrete member toward each of the opening sections 5 as above splits one row of the concrete member.

[0054]

Then, as shown in FIG. 5 (a), the new fracturing holes 25 are perforated on the sides of the new fracturing faces 27 in the region lengthwise direction at both end parts in the region width direction. After that, the same operations as in FIG. 4 (a) to FIG. 4 (d) are repeated to split the concrete member at the intermediate region 13 sequentially from the side of each of the opening section 5 toward the middle

part of the opening sections 5.

[0055]

In this way, as shown in FIG. 5 (b), approximately four rows of the concrete member are split until splitting the concrete member up to the middle part of the opening sections 5. After that, the concrete member that is left at the middle part and the split concrete member are broken for the secondary breaking by using nibblers, rippers, or the like to make the debris into the size which is easily removed. This state is shown in FIG. 1 (c).

[0056]

Then, when all the debris is removed as shown in FIG. 5 (c), demolishing of the concrete member at the belt-like planned demolishing region 3 is completed as shown in FIG. 1 (d).

[0057]

In the above process, the split concrete member may be removed when a certain amount thereof is accumulated. Also, the interval 7, the breadth 8 and the shape of the opening section 5, the size of the sequential core holes 19, the numbers and the positions of the fracturing holes 21 and 25, or the like are not limited to the above and may be optimally planned according to the dimensions of the planned demolishing region 3 or the size and the power of the heavy machine that can be used. Furthermore, although perforation of the fracturing holes 25 and splitting of the concrete member are repeated in the example shown in the drawings, it is also possible to perforate all the necessary fracturing holes 25 in advance in some cases.

[0058]

As above, according to the first embodiment, the concrete member at the intermediate region 13 between the opening sections 5 is split and broken after the opening sections 5 are formed at intervals. On this occasion, the process in which pressure is applied from the fracturing holes 25 that are perforated at appropriate positions to push out the concrete member toward the opening sections 5 and split it is repeated to do the splitting sequentially from each side of the opening sections 5. This method requires no large-sized heavy machines and small number of perforation so that the operation is easy and cost and work hours can be reduced. Also, the work can be done even in an underground narrow space with fewer problems of noise and vibration. Moreover, compared to the conventional method in which the area of a member within straight lines that join many holes is broken at once, the concrete member can be split with smaller applying pressure and problems such as scattering of the member may not occur.

[0059]

Also, if a concrete member is split as in the present embodiment, when only one opening section 5 is formed and the concrete member is pushed out repeatedly toward the opening section 5, approximately four rows of pushing-out is the limit. So, in the present embodiment, after previously forming a plurality of the opening sections 5, the concrete member at the intermediate region 13 is pushed out toward the opening sections 5 on both sides thereof to be split sequentially from each side of the opening sections 5. This can increase the length of the region of the concrete member that can be split in one series of operations. Thus, the planned demolishing region 3 can be efficiently demolished with fewer swapping of the heavy machines and the like.

[0060]

Also, in the present embodiment, by using the hydraulic breaker 15, the pressure can be applied only to the predetermined direction. Therefore, the concrete member can be pushed out to the intended direction, preventing unwanted cracks from being created in the surrounding concrete member and facilitating the breaking control. Also, since the pressure required for the splitting is proportional to the dimension of the concrete member after splitting, the pressure that is to be applied from the hydraulic breaker 15 can be calculated in advance, which is effective in work planning.

[0061]

Also, in the present embodiment, when forming the opening section 5, the concrete member is pushed out from the fracturing holes 21 to the direction of the sequential core holes 19 and split. Therefore, it is preferable that the common heavy machine and the like can be used as in splitting the concrete member at the intermediate region 13.

[0062]

In the present embodiment, although an example in which the planned demolishing region 3, which is a belt-like periphery part of the pressure resistant plate 105 of the pre-existing structure 103, is demolished, the object to which the present invention is applied is not limited thereto. For example, the present invention can be applied for demolishing various kinds of concrete members, mainly plate-like members, such as wall bodies like exterior walls, earth pressure walls, and temporary continuous walls, slabs and foundations. Also, various shapes of the planned demolishing region 3 may be considered. However, the effects of the demolishing method of the present invention are particularly great in demolishing

the pressure resistant plate 105 since the work is done in a narrow space and the periphery of the planned demolishing region 3 is restrained.

[0063]

Next, second to fifth embodiments, which are other examples of the present invention, will be described. Each embodiment is different from the first embodiment in a way of forming the opening section 5 and is similar to the first embodiment otherwise. Therefore, the same notations will be used in the drawings and the descriptions thereof will be omitted.

[0064]

(Second Embodiment)

First, a second embodiment of the present invention will be described. In this embodiment, in order to form the opening section 5, fracturing holes 33 are perforated as shown in FIG. 6. FIG. 6 shows the fracturing holes 33 in the opening section region: the upper drawing is a plan view of a vicinity of the opening section region and the lower drawing is a cross sectional view taken along the line A-A of the upper drawing.

[0065]

As shown in the drawings, the fracturing holes 33 include fracturing holes 33a and fracturing holes 33b.

[0066]

The fracturing holes 33a are formed by perforating holes downward at an angle from the vicinities of both sides of the center part of the opening section region in the region lengthwise direction toward the center part. The fracturing holes 33a are perforated through to shallow positions of the pressure resistant plate 105. A pair of the fracturing holes 33a in the region lengthwise direction have their bottom parts of which the positions thereof correspond to each other, being provided in approximately a V-shape in the vertical plane.

[0067]

The fracturing holes 33b are formed by perforating holes downward at an angle from both end parts of the opening section region in the region lengthwise direction toward the center part. The fracturing holes 33b are perforated through to deep positions of the pressure resistant plate 105. Similarly to the fracturing holes 33a, a pair of the fracturing holes 33b in the region lengthwise direction have their bottom parts of which the positions thereof correspond to each other, being provided in approximately a V-shape in the vertical plane.

[0068]

In the present embodiment, a hydraulic breaker 37 shown in FIG. 7 is used to split and break the concrete member. This hydraulic breaker 37 has a rod-shaped main body 38 provided with movable protrusion sections 39. After inserting the hydraulic breaker 37 with the retracted protrusion sections 39 into the fracturing hole 33 as shown in the left drawing, the protrusion sections 39 are protruded by hydraulic pressure as shown in the right drawing so that pressure is applied to the concrete member and the concrete member is pushed out and cracks can be generated.

[0069]

FIG. 8 illustrates the splitting of the concrete member in the opening section region. The upper drawings of FIG. 8 (a) to FIG. 8 (c) are plan views of the vicinities of the opening section region and the lower drawings thereof are the cross sectional views taken along the line B-B of the upper drawings.

[0070]

In the present embodiment, firstly, the hydraulic breaker 37 is inserted into each of the fracturing holes 33a shown in FIG. 6 and the protrusion sections 39 are protruded toward the surface of the pressure resistant plate 105. Then, the concrete member at a region surrounded by the fracturing holes 33a is pushed out toward the surface of the pressure resistant plate 105 and is split at the splitting faces 34 shown in FIG. 8 (a).

[0071]

Next, the hydraulic breaker 37 is inserted into each of the fracturing holes 33b to push out the concrete member at a region surrounded by the fracturing holes 33b toward the surface of the pressure resistant plate 105, in the same way as above. Then, the concrete member is split at the new splitting faces 34 shown in FIG. 8 (b).

[0072]

The concrete member that is split as above is then secondary broken if necessary and removed completely so that the opening section 5 is formed as shown in FIG. 8 (c). Then, the above-mentioned concrete member at the intermediate region 13 is split in the same way as in the first embodiment and the planned demolishing region 3 of the pressure resistant plate 105 can be demolished.

[0073]

In the second embodiment, since the concrete member is split by being pushed out toward the surface of the pressure resistant plate 105, there is an advantage that it saves time and effort such as securing movable space for the concrete

member by forming the sequential core holes 19 as in the first embodiment. Although the concrete member is pushed out simultaneously from a plurality of the fracturing holes 33a or the fracturing holes 33b in the present embodiment, it is also possible to push out one place at a time in turn. Also, although the hydraulic breaker 37 shown in FIG. 7 is used in the present embodiment, it is also possible to use the above-mentioned hydraulic breaker 15 shown in FIG. 3 (a) in the same way. Similarly, not only the hydraulic breaker 15 shown in FIG. 3 (a) but also the hydraulic breaker 37 shown in FIG. 7 can be used in the first embodiment too. The same can be said for the following embodiments.

[0074]

(Third Embodiment)

Next, a third embodiment of the present invention will be described with reference to FIG. 9.

[0075]

In the present embodiment, as shown in FIG. 9, a large-diameter core hole 41 having a diameter ranging the overall width of the planned demolishing region 3 is perforated to form the opening section 5. A small-sized perforating equipment such as a BG machine can be used to perforate the core hole 41.

[0076]

Then, the above-mentioned concrete member at the intermediate region 13 is split in the same way as in the first embodiment and the planned demolishing region 3 of the pressure resistant plate 105 can be demolished.

[0077]

According to the third embodiment, there is an advantage that the opening section 5 can be formed easily by perforating only one core hole 41.

[0078]

(Fourth Embodiment)

Next, a fourth embodiment of the present invention will be described with reference to FIG. 10.

[0079]

In the present embodiment, as shown in FIG. 10 (a), a middle-diameter core hole 51 having a diameter that is smaller than the overall width of the planned demolishing region 3 is perforated by using a BG machine or the like. Also, fracturing holes 53 are perforated on both sides in the region width direction of the core hole 51. The fracturing holes 53 are provided on both edge parts in the region width direction of the planned demolishing region 3.

[0080]

Next, hydraulic breakers are inserted into these fracturing holes 53 to apply pressure from the fracturing holes 53 toward the core hole 51 and push out the concrete member between each of the fracturing holes 53 and the core hole 51 toward the core hole 51 in the direction shown by the arrows. Then, the concrete member is split as shown in FIG. 10 (b) and splitting faces 55 are formed between each of the fracturing holes 53 and both edge parts in the region lengthwise direction of the core hole 51.

[0081]

After the concrete member that is split as above is secondary broken if necessary and removed, the opening section 5 is formed as shown in FIG. 10 (c). Then, the above-mentioned concrete member at the intermediate region 13 is split in the same way as in the first embodiment and the planned demolishing region 3 of the pressure resistant plate 105 can be demolished.

[0082]

According to the fourth embodiment, there are advantages that the number of perforations is small because only the core hole 51 and two fracturing holes 53 are perforated and, also, the breadth of the opening section 5 can be set variously by changing the diameter of the core hole 51.

[0083]

(Fifth Embodiment)

Next, a fifth embodiment of the present invention will be described with reference to FIG. 11.

[0084]

In the present embodiment, as shown in FIG. 11, sequential core holes 61 that are successive over the overall width of the planned demolishing region 3 are formed to form the opening section 5. The sequential core holes 61 are formed by perforating a plurality of sequential core holes in the region width direction in the same way as above.

[0085]

Then, the above-mentioned concrete member at the intermediate region 13 is split in the same way as in the first embodiment and the planned demolishing region 3 of the pressure resistant plate 105 can be demolished.

[0086]

According to the fifth embodiment, since the opening section 5 is formed by the sequential core holes 61, it is effective in a case for forming a narrow opening

section 5. If the opening section 5 is narrow and the concrete member at the intermediate region 13 is split as in the first embodiment, there may be no space for the claw parts to be inserted for secondary breaking by a nibbler. Therefore, it is preferable to use a ripper for its secondary breaking. In this case, it is satisfactory if the width of the opening section 5 of approximately 200 mm to 300 mm is secured.

[0087]

(Sixth Embodiment)

(1. Underground structure 71)

FIG. 12 shows an underground structure 71 that is to be demolished by a demolishing method according to a sixth embodiment of the present invention. FIG. 12 (a) is a front view of the underground structure 71, FIG. 12 (b) is a vertical cross sectional view of the underground structure 71, and FIG. 12 (c) is a horizontal cross sectional view of the underground structure 71. FIG. 12 (b) is a cross sectional view taken along the line C-C of FIG. 12 (a) and FIG. 12 (c) is a cross sectional view taken along the line D-D of FIG. 12 (a).

[0088]

The underground structure 71 is a structure built underground with concrete members such as a wall 73, a column 75, a beam 77, and the like. In the underground structure 71, the periphery of the wall 73 (underground wall), which is a plate-like member in vertical direction, is joined to the columns 75 (underground columns) and the beam 77 (underground beam) and is restrained.

[0089]

(2. Demolishing the wall 73)

In the demolishing method according to the present embodiment, the wall 73 of the underground structure 71 is demolished first. To demolish the wall 73, as shown in FIG. 13 (a), a slit-like groove 79 is formed at the lower part of a planned demolishing region 73a of the wall 73 in an approximately horizontal direction (the width direction of the planned demolishing region 73a). The groove 79 is formed, for example, by sequentially perforating a plurality of holes, but it is not limited thereto. Also, the inner faces of the groove 79 are exposed to the outside, being free faces without restraint.

[0090]

Next, a fracturing hole 83 is perforated above the groove 79 as shown in FIG. 13 (b). And, a hydraulic breaker is installed at the fracturing hole 83 and the concrete member of the wall 73 is split by using the hydraulic breaker.

[0091]

To split the concrete member, the wedge liner 17, which is a tip part of the hydraulic breaker 15, is inserted into the fracturing hole 83 as shown in the upper drawing of FIG. 15 (a), for example. Then, as shown in the lower drawing, the wedge-shaped wedge 18 is pushed in by hydraulic pressure to expand the wedge liner 17 vertically and apply pressure to the concrete member of the wall 73 as shown by the arrows E.

[0092]

Then, because of this pressure, the concrete member between the fracturing hole 83 and the groove 79 is pushed out to the groove 79 below, creating cracks 89 from both sides of the fracturing hole 83 toward the groove 79 below and splitting the concrete member thereby, as shown in FIG. 16 (a). Although the hydraulic breaker 15 applies pressure also toward the upper part of the fracturing hole 83, there is no free face on the upper part and, therefore, the pressure from the hydraulic breaker 15 solely acts as the force pushing out the concrete member downwardly.

[0093]

As for a hydraulic breaker, the hydraulic breaker 37 shown in FIG. 15 (b) can also be used. The hydraulic breaker 37 has the rod-shaped main body 38 provided with the movable protrusion sections 39 as described above and, after inserted into the fracturing hole 83 with the protrusion sections 39 retracted within the main body 38 as shown in the upper drawing, the protruding sections 39 are protruded by hydraulic pressure as shown in the lower drawing. This applies pressure to the concrete member of the wall 73 as shown by the arrows E in the same way as above, creating cracks 89 in the concrete member so that the concrete member can be split.

[0094]

FIG. 16 (b) shows a state of the split concrete member after a certain amount of time has passed. When the concrete member is split, the split concrete member subsides due to its own weight as shown by the arrow F and the widths of the cracks 89 increase.

[0095]

Thus, pressure is applied by the hydraulic breaker from the fracturing hole 83 and the concrete member is pushed out downward from the fracturing hole 83 toward the groove 79 so that the concrete member is split at the splitting faces, which are the cracks 89 created between the fracturing hole 83 and the groove 79.

The state after the concrete member is split is shown in FIG. 13 (c). Splitting faces 87 that split the concrete member become new free faces.

[0096]

In the present embodiment, a new fracturing hole 83 is then perforated adjacent to the fracturing hole 83 as shown in FIG. 13 (d) and pressure is applied in the same way as above by using the hydraulic breaker installed at the new fracturing hole 83 to push out the concrete member downward to be split. Here, the concrete member is split at the splitting faces 87 that join the new fracturing hole 83 with the previously formed fracturing hole 83 and the groove 79 respectively.

[0097]

In the present embodiment, the concrete member at the bottom row of the planned demolishing region 73a of the wall 73 is split by repeating the above process, as shown in FIG. 14 (a). After that, the concrete members at the upper rows are split in the same procedure. In this way, the concrete member of the planned demolishing region 73a is split from the bottom to the upper rows in turn so to split the concrete member of the entire planned demolishing region 73a of the wall 73 as shown in FIG. 14 (b).

[0098]

After the split concrete member is secondary broken and removed, an opening section 73b is formed at the planned demolishing region 73a as shown in FIG. 14 (c). For the secondary breaking, the concrete member can be broken by, for example, crushing the concrete member by the claws of nibbler that are inserted into the cracks 89 generated between the concrete members or by vibrating tips of a ripper that is inserted into the cracks 89. Since the width of the crack 89 increases due to the subsiding of the concrete member as described above, claws of the nibbler or tips of the ripper can be inserted easily and the secondary breaking can be done easily. Also, using a small-sized machine such as the nibbler or the ripper for the secondary breaking reduces the noise and vibration.

[0099]

Alternatively, the split concrete member may be removed at suitable points of the above-mentioned demolishing procedure instead of being secondary broken and removed all at once at the end as above. Also, although the concrete member of the upper row is split after the concrete member of the bottom row is split for the overall width of the planned demolishing region 73a in the example above, the concrete member of a part of the width direction of the planned demolishing region 73a may be split and then the concrete member of the upper part thereof may be

split afterwards. By repeating this process in the width direction of the planned demolishing region 73a, it is possible to split the concrete member of the entire planned demolishing region 73a.

[0100]

(3. Demolishing of the column 75 and the beam 77)

At the time of demolishing the column 75 and the beam 77 of the underground structure 71, a ground 72 behind the wall 73 is ploughed and taken out from the opening section 73b, which is formed by demolishing the planned demolishing region 73a of the wall 73, to be removed. This state is shown in FIG. 17 (a). In the example shown in FIG. 17 (a), the remaining part of the lower end part of the wall 73 is also removed at the time of removing the ground 72.

[0101]

In the present embodiment, the column 75 and the beam 77 are demolished by a wire saw, a nibbler, or the like making use of the space behind the underground structure 71 created by the removal of the ground 72. For example, in a case of a nibbler, a nibbler can crush and break the column 75 at once by holding the front face and the back face of the column 75 with claws 91 as shown in FIG. 17 (b). This is similar for the case of the beam 77: the nibbler can crush the beam 77 at once by holding the front face and the back face of the beam 77 with claws 91 as shown in FIG. 17 (c).

[0102]

If a wire saw is used, a wire 93 that is hooked around the back of the column 75 as shown in FIG. 17 (d) can cut the cross section of the column 75 in its horizontal direction at once. Also for the beam 77, the wire 93 that is hooked around the back of the beam 77 as shown in FIG. 17 (e) can cut the cross section of the beam 77 in its vertical direction at once. Using a nibbler or a wire saw can suppress noise and vibration to be small.

[0103]

Thus, according to the present embodiment, the wall 73, which is a plate-like concrete member in a vertical direction, can be demolished without using a large-sized heavy machine and with a few perforations. Also, pressure is applied from the fracturing hole 83 above the groove 79 and the concrete member is pushed out downward and split so that the split concrete member subsides due to its own weight, widening the cracks 89. This facilitates the secondary breaking with nibblers and the like and prevents the hydraulic breaker from being stuck, which improves the construction performance. Also, if a hydraulic breaker is used for

breaking the concrete member, it is possible to push out the concrete member toward the intended direction, which prevents unwanted cracks to be created in the surrounding concrete member, and there is an advantage that the breaking control can be facilitated.

[0104]

Also, in the present embodiment, by demolishing the wall 73 first and then removing the ground 72 behind the wall 73, it is possible to demolish the column 75 or the beam 77 easily by utilizing the space thereby so that the construction performance of the demolishing work of the underground structure 71 can be improved.

[0105]

In the present embodiment, the process of splitting of the concrete member, in which the fracturing hole 83 is perforated and pressure is applied from the fracturing hole 83, is repeated. This has an advantage that a new fracturing hole 83 can be perforated at a suitable place while taking the state of the breaking into consideration. However, it is also possible to perforate all the necessary fracturing holes 83 in advance.

[0106]

Others, such as the number and positions of the fracturing holes 83 or the demolishing procedure of the planned demolishing region 73a, are not limited to the descriptions above. These can be set to be the most suitable according to the conditions of the planned demolishing region 73a. Also, the range of the planned demolishing region 73 is not limited to the descriptions above, and it is considerable, for example, that only an upper part of the wall 73 is the planned demolishing region 73a. Also in this case, the groove 79 is formed below the planned demolishing region 73a and the concrete member of the planned demolishing region 73a can be demolished by the procedure described above. In addition, the object for demolishing by splitting a concrete member using a hydraulic breaker is not limited to the above-mentioned wall 73, but may be any of plate-like members in a vertical direction.

[0107]

Also, the method for demolishing the column 75 or the beam 77 is not limited to the method mentioned above. For example, in an example shown in FIG. 18 (a), there is a mountain retaining wall 72a behind the underground structure 71 and it is impossible to remove the ground 72 after demolishing the planned demolishing region 73a of the wall 73. However, in such a case, the claws 91 of a nibbler can

hold an inner side face of the column 75, which is exposed after demolishing and removing of the planned demolishing region 73a, and a face on the opposite side of the inner side face, so that the nibbler can crush the cross section of the column 75 in its horizontal direction. In a case in which a wire saw is used, as shown in FIG. 18 (b), a core hole 75a is perforated through the column 75 from its inner side face, which is exposed after removing of the planned demolishing region 73a, and the wire 93 that is passed through the core hole 75a can cut the cross section of the column 75 in its horizontal direction. The same can be said for the case of the beam 77.

[0108]

Thus, even if the ground 72 behind cannot be removed because of the existence of the mountain retaining wall 72a or the like, it is still possible to extend the area for crushing or cutting the column 75 or the beam 77 at once as much as the removed planned demolishing region 73a of the wall 73, and the construction performance of the demolishing work can be improved.

[0109]

Although the embodiments of the present invention have been described referring to the attached drawings, the technical scope of the present invention is not limited to the embodiments described above. It is obvious that persons skilled in the art can think out various examples of changes or modifications within the scope of the technical idea disclosed in the claims, and it will be understood that they naturally belong to the technical scope of the present invention.

DESCRIPTION OF NOTATIONS

[0109]

3, 73a planned demolishing region
5 opening section
13 intermediate region
14 debris
15, 37 hydraulic breaker
19, 61 sequential core holes
21, 25, 33, 33a, 33b, 53, 83 fracturing hole
23, 27, 34, 55, 87 splitting face
41, 51 core hole
71 underground structure
72, 101 ground

73 wall
75 column
77 beam
79 groove
89 crack
103 pre-existing structure
105 pressure resistant plate

WHAT IS CLAIMED IS

1. A demolishing method for demolishing a concrete member, the method comprising:

- a step (a) of forming opening sections at intervals in a planned demolishing region of the concrete member; and

- a step (b) of splitting the concrete member by applying pressure using a hydraulic breaker from fracturing holes perforated in the concrete member at an intermediate region between the opening sections to push the concrete member toward the opening sections, thereby splitting the concrete member, wherein

- the step (b) is repeated so that the concrete member at the intermediate region is split sequentially from each side of the opening sections.

2. The demolishing method according to claim 1, wherein:

- in the step (a),

- sequential core holes, in which a plurality of core holes are in sequence, are formed;

- the concrete member is pushed out from the fracturing holes that are perforated on the periphery of the sequential core holes toward the sequential core holes to be split; and

- the split concrete member is removed.

3. The demolishing method according to claim 1, wherein:

- in the step (a),

- the concrete member is pushed out from the fracturing holes perforated at an angle in a vertical plane toward a surface of the concrete member to be split; and

- the split concrete member is removed.

4. The demolishing method according to claim 1, wherein:

- in the step (a),

- a core hole having a diameter ranging the overall width of the planned demolishing region is perforated.

5. The demolishing method according to claim 1, wherein:
 - in the step (a),
 - a core hole having a diameter smaller than the overall width of the planned demolishing region is perforated;
 - the concrete member is pushed out from the fracturing holes that are perforated on both edge parts of the planned demolishing region in its width direction toward the core hole to be split; and
 - the split concrete member is removed.
6. The demolishing method according to claim 1, wherein:
 - in the step (a),
 - sequential core holes in which a plurality of core holes are in sequence are formed ranging the overall width of the planned demolishing region.
7. The demolishing method according to any one of the claims 1 to 6, wherein:
 - the concrete member is a pressure resistant plate of a structure.
8. A demolishing method comprising:
 - a step (a) of forming a groove at a lower part of a planned demolishing region of a plate-like concrete member of vertical plane direction along a width direction of the planned demolishing region; and
 - a step (b) of splitting the concrete member by applying pressure in upper and lower directions from fracturing holes perforated above the groove using hydraulic breaker to push the concrete member in a downward direction toward the groove, thereby splitting the concrete member, wherein,
 - the step (b) is repeated so that the concrete member of the planned demolishing region is split sequentially from the lower part to an upper part of the planned demolishing region.
9. The demolishing method according to claim 8, wherein:
 - the concrete member is an underground wall that is joined to an underground column or an underground beam; and
 - the underground column or the underground beam is demolished after demolishing the planned demolishing region of the underground wall.
10. The demolishing method according to claim 9, wherein:
 - the underground column or the underground beam is demolished after demolishing the planned demolishing region of the underground wall and removing the ground behind the underground wall.