

【DESCRIPTION】

【Invention Title】

DOUGHNUT-SHAPED HOLLOW CORE BODY, BIDIRECTIONAL HOLLOW
CORE SLAB USING THE SAME, AND CONSTRUCTION METHOD THEREOF

5 【Technical Field】

The present invention relates to a lightweight
bidirectional hollow core slab that is made by arranging a
plurality of hollow core bodies between upper and lower steel
bars in a form of a matrix in horizontal and vertical
10 directions thereof and by burying the hollow core bodies into
concrete, thereby providing bidirectional resistance
characteristics. More particularly, the present invention
relates to a doughnut-shaped hollow core body advantageously
used for a bidirectional hollow core slab, the bidirectional
15 hollow core body using the doughnut-shaped hollow core body,
and a construction method of the bidirectional hollow core
body.

【Background Art】

A hollow core slab has hollow cores formed on the center
20 thereof, which provide more excellent sectional performance
than the self weight and are advantageous in the reduction of
the noise between floors.

In view of the light weight of the slab, one of slab
systems used for current buildings is one-way hollow core
25 slab. Most of the slabs of buildings such as apartment
houses show bidirectional (two-way) movements, thereby making
it impossible to apply one-way hollow core slabs to the
buildings, without having any design changes and additional
costs. So as to solve the above-mentioned problems, thus,
30 there have been proposed bidirectional hollow core slabs
using spherical or oval plastic balls as hollow core bodies,
which are invented by BubbleDeck company in Netherland and

Cobiax company in Switzerland.

FIG.1 shows a bidirectional hollow core slab of the prior art. As shown, the bidirectional hollow core slab is configured by arranging ball-shaped hollow core bodies in rows and columns in such a manner as to be buried into concrete, so that the slab have bidirectional resistance characteristics. As shown in FIG.1, the bidirectional hollow core slab is formed wherein a slab lower portion and a slab upper portion are connected unitarily to each other by means of concrete filled between the ball-shaped hollow core bodies, thereby providing the bidirectional structure to the slab. Under the above-mentioned bidirectional hollow core slab, special attention should be paid to the fixation of the positions of the hollow core bodies.

The hollow rate generated by the shape and volume of the hollow core bodies in the bidirectional hollow core slab determines the amount of concrete of the slab and the amount of reduction of the slab weight and further defines the structural performance of the slab. In other words, the higher the hollow rate is, the smaller the amount of concrete of the slab is. In this case, however, the structural resistance of the slab becomes low. In case of the bidirectional hollow core slab, especially, the slab upper portion and the slab lower portion may be separated and moved from each other, while placing the hollow core bodies therebetween.

Therefore, there is a definite need for the development of a novel bidirectional hollow core slab capable of removing the reduction of the structural performance caused by the increment of the hollow rate thereof and improving the constructability thereof.

[Disclosure]

【Technical Problem】

Accordingly, the present invention has been made in view of the above-mentioned problems occurring in the prior art, and embodiments of the present invention seek to provide a hollow core body that has a substantially high hollow rate and is used for a bidirectional hollow core slab in a structurally stable state.

Embodiments of the present invention also seek to provide a bidirectional hollow core slab that is formed by stably locating hollow core bodies between upper and lower steel bars, thereby ensuring the quality of construction in the structural design.

Embodiments of the present invention further seek to provide a construction method of a bidirectional hollow core slab that is capable of simplifying the arrangement work of the steel bars.

【Technical Solution】

According to an aspect of the present invention, there is provided a hollow core body that is adapted to be buried into concrete for the construction of a lightweight concrete member, having a hollow portion with a circular section formed in the center thereof and corners rounded with curved surfaces, thereby providing a generally doughnut-shaped outer case.

According to another aspect of the present invention, there is provided a bidirectional hollow core slab comprising: steel bar cages made by coupling steel

bars; doughnut-shaped hollow core bodies spacedly arranged in rows and columns in such a manner as to be restrained in the steel bar cages; slab lower steel bars crossedly arranged as main bars and distributing bars beneath the steel bar cages; slab upper steel bars crossedly arranged as main bars and distributing bars on the steel bar cages; and slab concrete cast and cured to a thickness through which the slab lower and upper steel bars are buried, wherein each steel bar cage comprises: a first side bent bar bent and divided into a first inclined portion and first horizontal portions formed on both sides of the first inclined portion, the first side bent bar being inclinedly erected to form the first side thereof; a second side bent bar bent and divided into a second inclined portion and second horizontal portions formed on both sides of the second inclined portion, the second side bent bar being inclinedly erected toward the first side bent bar in such a manner as to face the first side bent bar, thereby forming the second side thereof, and the second inclined portion being located in a direction crossing the first inclined portion of the first side bent bar; an upper bent bar bent and divided into a third inclined portion and third horizontal portions formed on both sides of the third inclined portion, the upper bent bar being horizontally located on the upper portion between the first and second side bent bars facing each other, thereby forming the upper side thereof, and the third horizontal portions being connected to the first and second horizontal portions of the first and second side bent bars; a first end tilt bar located to inclinedly connect the first horizontal portion on one

end of the first side bent bar to the second horizontal portion on one end of the second side bent bar; and a second end tilt bar located to inclinedly connect the first horizontal portion on the other end of the first side bent bar to the second horizontal portion on the other end of the second side bent bar, and each doughnut-shaped hollow core body comprises fitting slots formed correspondingly on both sides facing each other, into which the first and second inclined portions of the first and second side bent bars are insertedly fitted, so that the hollow core bodies are inserted into the steel bar cages and the first and second inclined portions of the first and second side bent bars are insertedly fitted to the fitting slots, thereby being restrained into the steel bar cages.

According to another aspect, there is provided a bidirectional hollow core slab comprising: steel bar cages made by coupling steel bars; doughnut-shaped hollow core bodies spacedly arranged in rows and columns in such a manner as to be restrained in the steel bar cages; slab lower steel bars arranged as main bars beneath the steel bar cages; slab upper steel bars arranged as main bars on the steel bar cages in a direction parallel to the slab lower steel bars; and slab concrete cast and cured to a thickness through which the slab lower and upper steel bars are buried, wherein each steel bar cage comprises: first and second lower horizontal bars spaced apart from each other in parallel with each other; first and second upper horizontal bars spaced apart from each other with a width smaller than the first and second lower horizontal bars above the first and second lower horizontal bars; a first side tilt

bars adapted to connect the first upper and lower horizontal bars to each other, while being inclined to each other along the lengthwise directions of the first upper and lower horizontal bars in such a manner where the inclined directions of the neighboring first side tilt bars are opposite to each other; second side tilt bars adapted to connect the second upper and lower horizontal bars to each other, while being inclined to each other along the lengthwise directions of the second upper and lower horizontal bars in such a manner where the inclined directions of the second side tilt bars are opposite to those of those of the first side tilt bars in such a manner as to cross the first side tilt bars; upper tilt bars adapted to connect the first and second upper horizontal bars to each other, while being inclined to each other along the lengthwise directions of the first and second upper horizontal bars in such a manner as to connect the first and second side tilt bars facing each other; a first end tilt bar adapted to inclinedly connect one end portion of the first upper horizontal bar and one end portion of the second lower horizontal bar; and a second end tilt bar adapted to inclinedly connect the other end portion of the first upper horizontal bar and the other end portion of the second lower horizontal bar or to inclinedly connect the other end portion of the second upper horizontal bar and the other end portion of the first lower horizontal bar, and each doughnut-shaped hollow core body comprises fitting slots formed correspondingly on both sides facing each other, into which the first and second side tilt bars are insertedly fitted, so that the hollow core bodies are inserted into the steel bar cages and the first

and second side tilt bars are insertedly fitted to the fitting slots, thereby being restrained into the steel bar cages.

According to another aspect, there is provided a bidirectional hollow core slab comprising: doughnut-shaped hollow core bodies spacedly arranged in rows and columns; slab lower steel bars arranged as main bars and distributing bars beneath the doughnut-shaped hollow core bodies; slab upper steel bars arranged as main bars and distributing bars on the doughnut-shaped hollow core bodies; steel bar spacers disposed between the doughnut-shaped hollow core bodies and the distributing bars of the slab lower and upper steel bars; and slab concrete cast and cured to a thickness through which the slab lower and upper steel bars are buried, wherein each steel bar spacer comprises: a steel bar coupling piece formed to be welded or fitted to the distributing bars; and a protrusion formed to be fitted to each doughnut-shaped hollow core body, and each doughnut-shaped hollow core body comprises fitting slots formed on the top and underside surfaces facing each other, so that the protrusions of the steel bar spacers are fitted to the fitting slots, thereby being restrained into the distributing bars.

【Advantageous Effects】

According to the present invention, the following advantages can be expected.

Firstly, the hollow core slab with the bidirectional resistance characteristics can be constructed in a structurally stable state. Especially, the slab concrete is filled into the hollow portions of the doughnut-shaped hollow core bodies, so that the unification of the upper and lower portions placing the hollow core bodies therebetween can be improved to construct the structurally reinforced hollow core slab.

Secondly, the hollow core bodies are buried into the slab concrete in the state of being restrained in the steel bar cages or the steel bar spacers, so that they can be located on the center between the slab upper and lower steel bars to ensure the quality of construction, and more particularly, the steel bar cages serve to fix the positions of the hollow core bodies as well as serve as shear steel bars in the state of being restrained in the slab concrete, thereby constructing a structurally advantageous hollow core slab.

Lastly, the distributing bars of the upper and lower steel bars of the bidirectional hollow core slab can be in advance coupled to the steel bar cages or steel bar spacers for fixing the positions of the hollow core bodies, thereby permitting the arrangement work of the slab steel bars to be simplified.

【Description of Drawings】

FIG.1 shows a bidirectional hollow core slab of the prior art.

FIGS.2 and 3 show doughnut-shaped hollow core bodies according to the present invention.

FIG.4 shows a bidirectional hollow core slab constructed by using the doughnut-shaped hollow core body of FIG.2.

FIGS.5 to 7 show a steel bar cage formed of bent bars

and the doughnut-shaped hollow core body of FIG.2 restrainedly mounted in the steel bar cage.

FIGS.8 and 9 show the process for constructing the bidirectional hollow core slab using the steel bar cage of FIG.7 and the section of the finished bidirectional hollow core slab.

FIGS.10 and 11 show a steel bar cage formed of horizontal bars and the doughnut-shaped hollow core body of FIG.2 restrainedly mounted in the steel bar cage.

FIGS.12 and 13 show the process for constructing the bidirectional hollow core slab using the steel bar cage of FIG.11 and the section of the finished bidirectional hollow core slab.

FIGS.14 and 15 show steel bar spacers and the state where the doughnut-shaped hollow core bodies of FIG.3 are disposed using the steel bar spacers.

FIG.16 shows the section of the bidirectional hollow core slab made by using the steel bar spacers of FIG.14.

【Best Mode for Invention】

According to a first aspect of the present invention, there is provided a hollow core body that is adapted to be buried into concrete for the construction of a lightweight concrete member, having a hollow portion with a circular section formed in the center thereof and corners rounded with curved surfaces, thereby providing a generally doughnut-shaped outer case.

According to a second aspect of the present invention, there is provided a bidirectional hollow core slab including: steel bar cages each having first and second side bent bars, an upper bent bar, and first and second end tilt bars; doughnut-shaped hollow core bodies spacedly arranged in rows and columns in such a manner as to be restrained in the steel

bar cages by means of fitting slots formed on both sides facing each other; slab lower steel bars arranged beneath the steel bar cages; slab upper steel bars arranged on the steel bar cages; and slab concrete cast and cured to a thickness
5 through which the slab lower and upper steel bars are buried.

According to a third aspect of the present invention, there is provided a bidirectional hollow core slab including: steel bar cages having first and second upper and lower horizontal bars, first and second side tilt bars, upper tilt
10 bars, and first and second end tilt bars; doughnut-shaped hollow core bodies spacedly arranged in rows and columns in such a manner as to be restrained in the steel bar cages by means of fitting slots formed on both sides facing each other; slab lower steel bars arranged beneath the steel bar
15 cages; slab upper steel bars arranged on the steel bar cages; and slab concrete cast and cured to a thickness through which the slab lower and upper steel bars are buried.

According to a fourth aspect of the present invention, there is provided a bidirectional hollow core slab including:
20 doughnut-shaped hollow core bodies spacedly arranged in rows and columns; slab lower steel bars arranged as main bars and distributing bars beneath the doughnut-shaped hollow core bodies; slab upper steel bars arranged as main bars and distributing bars on the doughnut-shaped hollow core bodies;
25 steel bar spacers disposed and coupled between the doughnut-shaped hollow core bodies and the slab lower and upper steel bars; and slab concrete cast and cured to a thickness through which the slab lower and upper steel bars are buried,

According to a fifth aspect of the present invention,
30 there is provided a construction method of a bidirectional hollow core slab, including the steps of: arranging slab lower steel bars; disposing steel bar cages into which

doughnut-shaped hollow core bodies are restrained on the slab lower steel bars; arranging slab upper steel bars on the steel bar cages; and casting and curing slab concrete onto the slab lower and upper steel bars.

5 【Mode for Invention】

Hereinafter, an explanation on a doughnut-shaped hollow core body, a bidirectional hollow core slab using the same, and a construction method thereof according to the present invention will be given with reference to the attached
10 drawings.

FIGS.2 and 3 show doughnut-shaped hollow core bodies according to the present invention.

A hollow core body 100 is buried into concrete so that the space in which the hollow core body 100 is disposed is
15 not filled with the concrete, thereby providing a lightweight concrete member. That is, the hollow core body 100 serves as a hollow core to give a light weight to the concrete member.

According to the present invention, especially, the hollow core body 100 has a hollow portion 110 formed on the
20 center thereof, thereby having a generally doughnut-shaped outer case. That is, the doughnut-shaped hollow core body according to the present invention is configured wherein the hollow portion 110 with a circular section is formed in the center thereof and corners are rounded with curved surfaces,
25 thereby providing a generally doughnut-shaped outer case.

Further, the doughnut-shaped hollow core body 100 according to the present invention has a cavity area 120 formed into the doughnut-shaped outer case and two or more constitution parts 100a and 100b coupled to each other. The
30 cavity area 120 serves to further provide the light weight to the doughnut-shaped hollow core body 100, and the coupling structure of the constitution parts 100a and 100b enables the

constitution parts 100a and 100b to be laid on top of each other, thereby minimizing their volume while carried. The cavity area 120 may be filled with an insulation material like Styrofoam and sound-proof and vibration-proof materials like rubber, and in this case, the doughnut-shaped hollow core body 100 can be advantageously applied to the places where the insulation and the vibration-proof resistance are needed.

In the doughnut-shaped hollow core body 100, as shown in FIGS.2 and 3, the two constitution parts 100a and 100b are coupled to each other, wherein in FIG.2 they are coupled by means of stepped protrusions 131a and 131b formed to correspond to each other, and in FIG.3 they are locked by means of protruding pieces 132a and locking members 132b formed to correspond to each other.

On the other hand, it is checked from FIGS.2 and 3 that fitting slots 140a, 140b and 140c are formed on the outer case of the doughnut-shaped hollow core body 100. The fitting slots 140a, 140b and 140c are provided to restrain the doughnut-shaped hollow core body 100 into a steel bar cage 200 or a steel bar spacer 300. Especially, the doughnut-shaped hollow core body 100 of FIG.3 has the X-shaped fitting slots 140a formed on the sides thereof and straight line-shaped fitting slots 140b and trapezoidal fitting slots 140c formed on the top and underside surfaces thereof, which enables the doughnut-shaped hollow core body 100 to be utilized commercially irrespective of the kinds of the steel bar cage 200 and the steel bar spacer 300.

The doughnut-shaped hollow core body 100 can be made with a weight lower than the concrete when they have the same volume as each other, and when it is considered that concrete is not recyclable, desirably, the concrete can be replaced

with the hollow core body 100 made of an eco-friendly material. For example, the hollow core body 100 is made of eco-friendly bio plastic such as biodegradable plastic, biomass plastic and so on. The biomass plastic is a polymer made with recyclable organic resources (PLA and natural fiber) as a raw material, thereby inducing the reduction of the amount of fossil resources to be used. So, an amount of CO₂ can be decreased by the amount of biomass replaced. Further, the hollow core body 100 may be made of plastic (PP, PE, etc.), and especially, if it is made of reinforced plastic to which about 40% glass fiber GF is added, the strength (tension and compression) of the hollow core body can be increased by about 2 to 3 times.

The hollow core body 100 for constructing the bidirectional hollow core slab desirably has a height H in a range between 120mm and 150mm, lengths L1 and L2 in a range between 90mm and 270mm, and a diameter D of the hollow portion 110 thereof in a range between 15mm and 45mm. The height H of the hollow core body 100 is obtained in consideration of the thickness of the hollow core slab and the covering thickness of upper and lower steel bars of the hollow core slab, the lengths L1 and L2 thereof are obtained in consideration of the hollow rate (more than 30%) of the hollow core slab, and the diameter D is obtained in consideration of the compactibility of slab concrete and the hollow rate of the hollow core slab.

FIG.4 shows a bidirectional hollow core slab constructed by using the doughnut-shaped hollow core body of FIG.2. The bidirectional hollow core slab is made by spacedly arranging the doughnut-shaped hollow core bodies 100 in rows and columns in a form of a matrix between upper and lower steel bars 411, 412, 413 and 414 and by burying the hollow core

bodies 100 into slab concrete 420.

More particularly, the slab concrete 420 is filled in the hollow portions 110 of the hollow core bodies 100, and thus, the concrete portions are formed at a given interval
5 irrespective of the sizes of the hollow core body 100, thereby enabling the bidirectional hollow core slab to be constructed in a structurally stable manner. That is, the slab lower portion into which the lower steel bars 411 and 412 are buried and the slab upper portion into which the
10 upper steel bars 413 and 414 are buried are connected unitarily to each other by means of the concrete portions filled between the neighboring hollow core bodies 100 and filled into the hollow portions 110 of the hollow core bodies 100, thereby strengthening the stability of the hollow core
15 slab. As a analysis result, it is found that concrete is filled into the hollow portions 110, thereby increasing the strength of the hollow core slab and decreasing the deflection of the hollow core slab, and further, it is found that the corners of the hollow core bodies 100 are rounded to
20 distribute the cracks of the concrete and to delay the breakage thereof.

On the other hand, it is important to fix the positions of the hollow core bodies 100 in the construction of the bidirectional hollow core slab. According to the present
25 invention, there are two methods for fixing the positions of the hollow core bodies 100 through steel bar cages 200 and through steel bar spacers 300. FIGS.5 to 13 show the method for fixing the positions of the hollow core bodies 100 through the steel bar cages 200, and FIGS.14 to 16 show the
30 method for fixing the positions of the hollow core bodies 100 through the steel bar spacers 300. The steel bar cages 200 and the steel bar spacers 300 control the mobility of the

hollow core bodies 100, thereby allowing them to be stably positioned between the upper and lower steel bars 411, 412, 413 and 414.

Each steel bar cage 200 adapted to fix the position of the hollow core body 100, as shown in FIGS.5 to 13, is made by connecting steel bars (or steel wires, or materials equivalent to the steel bars) and configured to restrain and mount the hollow core body 100 thereinto. After the steel bar cages 200 are buried into the slab concrete 420, they are restrained by the slab concrete 420 to supplement the reduction of the shear performance caused by the loss of the section through the hollow core body 100.

FIGS.5 to 7 show steel bar cages formed of bent bars and the doughnut-shaped hollow core body of FIG.2 restrainedly mounted in the steel bar cage. The steel bar cage 200 of FIG.5 has a basic structure in which one hollow core body 100 is restrainedly mounted. The steel bar cage 200 of FIG.6 has a structure wherein the steel bar cage of FIG.5 is extended by two times to restrain and mount two hollow core bodies 100 thereinto. The steel bar cage 200 of FIG.7 has a structure wherein the steel bar cage of FIG.5 is extended by four times to restrain and mount four hollow core bodies 100 thereinto. Of course, the steel bar cage 200 can be extended to various lengths from that of FIG.5.

The steel bar cage of FIG.5 is made by coupling first and second side bent bars 210 and 220, an upper bent bar 230, and first and second end tilt bars 241 and 242 by means of welding. The first side bent bar 210 is bent and divided into a first inclined portion 211 and first horizontal portions 212 formed on both sides of the first inclined portion 211, in such a manner as to be inclinedly erected to form the first side of the steel bar cage 200. The second

side bent bar 220 is bent and divided into a second inclined portion 221 and second horizontal portions 222 formed on both sides of the second inclined portion 221 in such a manner as to be inclinedly erected toward the first side bent bar 210, while facing the first side bent bar 210, thereby forming the second side of the steel bar cage 200. Further, the second inclined portion 221 is located in a direction crossing the first inclined portion 211 of the first side bent bar 210. The upper bent bar 230 is bent and divided into a third inclined portion 231 and third horizontal portions 232 formed on both sides of the third inclined portion 231 in such a manner as to be horizontally located on the upper portion between the first and second side bent bars 210 and 220 facing each other, thereby forming the upper side of the steel bar cage 200. Further, the third horizontal portions 232 are connected rigidly to the first and second horizontal portions 212 and 222 of the first and second side bent bars 210 and 220. The first end tilt bar 241 is located to inclinedly connect the first horizontal portion 212 on one end of the first side bent bar 210 to the second horizontal portion 222 on one end of the second side bent bar 220. The second end tilt bar 242 is located to inclinedly connect the first horizontal portion 212 on the other end of the first side bent bar 210 to the second horizontal portion 222 on the other end of the second side bent bar 220.

The steel bar cages 200 of FIGS.6 and 7 have the structures wherein the steel bar cage of FIG.5 is extended in such a manner as to be continuously bent to a trapezoidal shape for the first and second side bent bars 210 and 220 and the upper bent bar 230. That is, the steel bar cage 200 of FIG.6 is made by coupling the first and second side bent bars 210 and 220 and the upper bent bar 230 having two first,

second and third inclined portions 211, 221 and 231 and the first, second and third horizontal portions 212, 222 and 232 at both ends thereof. The steel bar cage 200 of FIG.7 is made by coupling the first and second side bent bars 210 and 220 and the upper bent bar 230 having four first, second and third inclined portions 211, 221 and 231 and the first, second and third horizontal portions 212, 222 and 232 at both ends thereof. The steel bar cage 200 of FIG.7 has a desirable size applicable to the construction site when considering all conditions inclusive of conveyance and work site.

The steel bar cages 200 of FIGS.5 to 7 have the whole outer shape of a hexahedron, and thus, they can be erected by themselves. That is, the first and second side bent bars 210 and 220 constitute both sides of the hexahedron, the upper bent bar 230 an upper side thereof, and the first and second tilt bent bars 241 and 242 front and rear sides thereof, and then the first and second horizontal portions 212 and 222 of the first and second side bent bars 210 and 220 become the support points of the hexahedron, thereby making the steel bar cage 200 erected by itself. Especially, the first and second side bent bars 210 and 220 are inclined toward each other, so that the front and rear sides of the steel bar cage 200 have the trapezoidal shapes (see FIGS.5b, 6b and 7b).

It is checked from FIGS.5c, 6c and 7c that the doughnut-shaped hollow core body 100 of FIG.2 is restrainedly mounted into the steel bar cage 200. So as to restrainedly mount the hollow core body 100 into the steel bar cage 200, the hollow core body 100 should have the fitting slots 140a formed on both sides facing each other. In this case, if the hollow core body 100 is inserted into the steel bar cage 200, the first and second inclined portions 211 and 221 of the first and second side bent bars 210 and 220 are insertedly fitted

to the fitting slots 140a to permit the hollow core body 100 to be restrained into the steel bar cage 200. After the hollow core body 100 has been restrained into the steel bar cage 200, even if a given buoyancy is applied to the hollow core body 100 while the slab concrete 420 is being cast, the hollow core body 100 is locked to the first and second side bent bars 210 and 220 inclined toward each other and the floating of the hollow core body 100 is thus suppressed. As a result, the hollow core body 100 is stably buried at a given position into the slab concrete 420. When considering the construction state of the hollow core body 100, generally, a plurality of hollow core bodies 100 are restrained into one steel bar cage 200, as shown in FIG.6 and FIG.7, and in this case, the arrangement intervals of the plurality of hollow core bodies 100 can be adjusted by means of the lengths of the first, second and third horizontal portions 212, 222 and 232 located in the middle of the first and second side bent bars 210 and 220 and the upper bent bar 230.

On the other hand, the hollow core body 100 of FIG.2 has both side fitting slots 140a formed in the same arrangements of the first and second inclined portions 211 and 221 of the first and second side bent bars 210 and 220, and the hollow core body 100 of FIG.3 has both side fitting slots 140a formed to a shape of 'X' crossing the arrangements of the first and second inclined portions 211 and 221 of the first and second side bent bars 210 and 220. In this case, the hollow core body 100 of FIG.3 is more advantageous than the hollow core body 100 of FIG.2 because it has no limitation in the direction of the installation. In more detail, in case of the hollow core body 100 of FIG.2, the directions of the fitting slots 140a formed should correspond to the directions of the first and second inclined portions

211 and 221 of the first and second side bent bars 210 and 220, and contrarily, in case of the hollow core body 100 of FIG.3, the directions of the first and second inclined portions 211 and 221 of the first and second side bent bars 210 and 220 correspond to the directions of the fitting slots 140a formed on both sides of the hollow core body 100, which has no limitation in the direction of installation.

FIG.8 and 9 show the process for constructing the bidirectional hollow core slab using the steel bar cage of FIG.7 and the section of the finished bidirectional hollow core slab. In this case, the same process is applied to the steel bar cages 200 as shown in FIGS.5 and 6. The bidirectional hollow core slab is constructed first by crossedly arranging main bars 411 and distributing bars 412 as the lower steel bars, disposing the steel bar cages 200 into which the doughnut-shaped hollow core bodies 100 are restrained on the lower steel bars 411 and 412, crossedly arranging distributing bars 413 and main bars 414 as the upper steel bars on the steel bar cages 200, and casting and curing the slab concrete 420 thereon. At this time, the steel bar cages 200 are tied by means of a binding wire in such a manner as to be fixed to the lower steel bars 411 and 412. On the other hand, the steel bar cages 200 serve as spacers for constantly maintaining the arrangement positions of the upper steel bars 413 and 414.

FIGS.10 and 11 show a steel bar cage formed of horizontal bars, wherein the steel bar cage is made with the distributing bars of the upper and lower steel bars of the slab.

The steel bar cage of FIG.10 is made by coupling first and second upper and lower horizontal bars 251, 252, 253 and 254, first and second side tilt bars 261 and 262, upper tilt

bars 263, and first and second end tilt bars 241 and 242 by means of welding. The first and second lower horizontal bars 251 and 252 are spaced apart from each other in parallel with each other, and above the first and second lower horizontal bars 251 and 252, the first and second upper horizontal bars 253 and 254 are spaced apart from each other with a width smaller than the first and second lower horizontal bars 251 and 252. Accordingly, the first and second upper and lower horizontal bars 251, 252, 253 and 254 have a trapezoidal arrangement structure. The first side tilt bars 261 connect the first upper and lower horizontal bars 251 and 253 to each other, while being inclined to each other along the lengthwise directions of the first upper and lower horizontal bars 251 and 253, and in this case, the inclined directions of the neighboring first side tilt bars 261 are opposite to each other. The second side tilt bars 262 connect the second upper and lower horizontal bars 252 and 254 to each other, while being inclined to each other along the lengthwise directions of the second upper and lower horizontal bars 252 and 254, and in this case, the inclined directions of the second side tilt bars 262 are opposite to those of the first side tilt bars 261 in such a manner as to cross the first side tilt bars 261. The upper tilt bars 263 connect the first and second upper horizontal bars 253 and 254 to each other, while being inclined to each other along the lengthwise directions of the first and second upper horizontal bars 253 and 254, and thus, they connect the first and second side tilt bars 261 and 262 facing each other. The first end tilt bar 241 inclinedly connects one end portion of the first upper horizontal bar 253 and one end portion of the second lower horizontal bar 252, and the second end tilt bar 242 inclinedly connects the other end portion of the first upper

horizontal bar 253 and the other end portion of the second lower horizontal bar 252, or inclinedly connects the other end portion of the second upper horizontal bar 254 and the other end portion of the first lower horizontal bar 251. In the steel bar cage 200 as shown in FIG.10, the first and second upper and lower horizontal bars 251, 252, 253 and 254 are used as the distributing bars 412 and 413 of the upper and lower steel bars of the slab.

The steel bar cage 200 as shown in FIG.10 has the whole outer appearance similar to the steel bar cages 200 as shown in FIGS.5 to 7. The first and second upper and lower horizontal bars 251, 252, 253 and 254 correspond to the first, second and third horizontal portions 212, 222 and 232 of the first and second side bent bars 210 and 220 and the upper bent bar 230, the first and second side tilt bars 261 and 263 correspond to the first and second inclined portions 211 and 221 of the first and second side bent bars 210 and 220, and the upper tilt bars 263 have the same arrangements as the third inclined portion 231 of the upper bent bar 230. Accordingly, the hollow core bodies 100 are restrained in the steel bar cage 200 as shown in FIG.10, in the same manner as the steel bar cages 200 as shown in FIGS.5 to 7.

The steel bar cage 200 as shown in FIG.11 is made by welding the first and second upper and lower horizontal bars 251, 252, 253 and 254 to the steel bar cage 200 as shown in FIG.7. That is, the first horizontal bars 212 located at the lower portions of the first side bent bars 210 are connected to each other by means of the first lower horizontal bar 251, the second horizontal bars 222 located at the lower portions of the second side bent bars 220 are connected to each other by means of the second lower horizontal bar 252, the connected portions between the first horizontal bars 212

located at the upper portions of the first side bent bars 210 and the third horizontal bars 232 located at one sides of the upper bent bars 230 are connected to each other by means of the first upper horizontal bar 253, and the connected
5 portions between the second horizontal bars 222 located at the upper portions of the second side bent bars 220 and the third horizontal bars 232 located at the other sides of the upper bent bars 230 are connected to each other by means of the second upper horizontal bar 254. Since the first and
10 second upper and lower horizontal bars 251, 252, 253 and 254 are used as the distributing bars 412 and 413 of the upper and lower steel bars of the slab, the steel bar cage 200 as shown in FIG.11 is made by in advance welding the distributing bars 412 and 413 of the upper and lower steel
15 bars of the slab to the steel bar cage 200 as shown in FIG.7.

In case of the steel bar cage 200 formed of the horizontal bars as shown in FIGS.10 and 11, desirably, both ends of each of the first and second upper and lower horizontal bars 251, 252, 253 and 254 are more extended than
20 the other portions, and the extended one ends are bent. As a result, when the steel bar cages 200 are continuously arranged serially, the first and second upper and lower horizontal bars 251, 252, 253 and 254 can be connected to the neighboring first and second upper and lower horizontal bars
25 251, 252, 253 and 254.

FIGS.12 and 13 show the process for constructing the bidirectional hollow core slab using the steel bar cage of FIGS.11a to 11c and the section of the finished bidirectional hollow core slab, and in this case, the same process is
30 applied to the steel bar cage 200 as shown in FIG.10. The steel bar cage 200 as shown in FIG.11 is made by welding the first and second upper and lower horizontal bars 251, 252,

253 and 254 to the steel bar cage 200 as shown in FIG.7, so that if the steel bar cage 200 as shown in FIG.11 is used, the process of arranging the distributing bars 412 and 413 in the arrangements of the upper and lower steel bars of the slab can be avoided.

Steel bar spacers 300 as shown in FIGS.14 to 16, which are adapted to fix the positions of the hollow core bodies 100, are configured to be coupled to the hollow core bodies 100 and the distributing bars 312 and 413, while being located between the hollow core bodies 100 and the distributing bars 312 and 413. In more detail, each steel bar spacer 300 includes a steel bar coupling piece 310 formed to be welded or fitted to the distributing bars 412 and 413 and a protrusion 320 formed to be fitted to the hollow core body 100.

FIG.14 show the example of the steel bar spacers 300 made of steel bars. The steel bar spacers 300 as shown in FIG.14 are formed by continuously bending the steel bar to form the U-shaped protrusions 320 at the center portions and the horizontal steel bar coupling pieces 310 at both ends thereof in such a manner as to be welded to the distributing bars 412 and 413.

FIG.15 show the example of the steel bar spacers 300 made by means of plastic injection molding. The steel bar spacers 300 as shown in FIG.15, which are used in the conventional practice, are formed of the steel bar coupling pieces 310 open by elasticity and the elastic protrusions 320 of a trapezoidal shape formed on the lower portion of the steel bar coupling pieces 310, so that the distributing bars 412 and 413 are fitted to the steel bar coupling pieces 310.

It is appreciated from FIGS.14b and 15b that the doughnut-shaped hollow core bodies 100 of FIG.3 are coupled

to the steel bar spacers 300. So as to couple the hollow core bodies 100 to the steel bar spacers 300, each hollow core body 100 should have the fitting slots 140b and 140c formed on the top and underside surfaces thereof, and at this time, the fitting slots 140b and 140c should have the corresponding shape to the protrusions 320 of the steel bar spacers 300, so that when the hollow core bodies 100 are coupled to the steel bar spacers 300, the protrusions 320 are fitted to the fitting slots 140b and 140c, thereby achieving the coupling. After the hollow core bodies 100 have been coupled to the steel bar spacers 300, even if a given buoyancy is applied to the hollow core bodies 100 while the slab concrete 420 is being cast, the floating of the hollow core bodies 100 is suppressed by the weight of the upper distributing bars 413 coupled to the steel bar coupling pieces 310 of the steel bar spacers 300, and thus, the hollow core bodies 100 are stably buried at a given position into the slab concrete 420. The bidirectional hollow core slab made by using the steel bar spacers 300 is shown in FIG.16.

While the present invention has been described with reference to the particular illustrative embodiments, it is not to be restricted by the embodiments but only by the appended claims. It is to be appreciated that those skilled in the art can change or modify the embodiments without departing from the scope and spirit of the present invention.

【CLAIMS】**【Claim 1】**

A hollow core body, which is adapted to be buried into concrete for the construction of a lightweight concrete member, having a hollow portion with a circular section formed in the center thereof and corners rounded with curved surfaces, thereby providing a generally doughnut-shaped outer case.

【Claim 2】

The hollow core body as defined in claim 1, wherein a cavity area is formed in the doughnut-shaped outer case.

【Claim 3】

The hollow core body as defined in claim 2, wherein the cavity area is filled with an insulation material or a vibration-proof material.

【Claim 4】

The hollow core body as defined in claim 2, wherein two or more constitution parts are coupled to each other to form the hollow core body, each of the constitution parts being made of any one of reinforced plastic into which glass fiber is mixed, biodegradable plastic, and biomass plastic.

【Claim 5】

The hollow core body as defined in any one of claims 1 to 4, wherein a height H of the hollow core body is in a range between 120mm and 150mm, lengths L1 and L2 thereof in a range between 90mm and 270mm, and a diameter D of the hollow portion thereof in a range between 15mm and 45mm.

【Claim 6】

A bidirectional hollow core slab comprising:
steel bar cages made by coupling steel bars;

doughnut-shaped hollow core bodies spacedly arranged in rows and columns in such a manner as to be restrained in the steel bar cages;

slab lower steel bars crossedly arranged as main bars and distributing bars beneath the steel bar cages;

slab upper steel bars crossedly arranged as main bars and distributing bars on the steel bar cages; and

slab concrete cast and cured to a thickness through which the slab lower and upper steel bars are buried,

wherein each steel bar cage comprises: a first side bent bar bent and divided into a first inclined portion and first horizontal portions formed on both sides of the first inclined portion, the first side bent bar being inclinedly erected to form the first side thereof; a second side bent bar bent and divided into a second inclined portion and second horizontal portions formed on both sides of the second inclined portion, the second side bent bar being inclinedly erected toward the first side bent bar in such a manner as to face the first side bent bar, thereby forming the second side thereof, and the second inclined portion being located in a direction crossing the first inclined portion of the first side bent bar; an upper bent bar bent and divided into a third inclined portion and third horizontal portions formed on both sides of the third inclined portion, the upper bent bar being horizontally located on the upper portion between the first and second side bent bars facing each other, thereby forming the upper side thereof, and the third

horizontal portions being connected to the first and second horizontal portions of the first and second side bent bars; a first end tilt bar located to inclinedly connect the first horizontal portion on one end of the first side bent bar to the second horizontal portion on one end of the second side bent bar; and a second end tilt bar located to inclinedly connect the first horizontal portion on the other end of the first side bent bar to the second horizontal portion on the other end of the second side bent bar, and

each doughnut-shaped hollow core body comprises fitting slots formed correspondingly on both sides facing each other, into which the first and second inclined portions of the first and second side bent bars are insertedly fitted, so that the hollow core bodies are inserted into the steel bar cages and the first and second inclined portions of the first and second side bent bars are insertedly fitted to the fitting slots, thereby being restrained into the steel bar cages.

【Claim 7】

The bidirectional hollow core slab as defined in claim 6, wherein the first and second side bent bars and the upper bent bar of each steel bar cage are continuously bent to a trapezoidal shape to provide two or more first, second and third inclined portions, thereby forming the first, second and third horizontal portions at both ends of the respective inclined portions, and each steel bar cage has the plurality of doughnut-shaped hollow core bodies restrainedly inserted thereinto.

【Claim 8】

A bidirectional hollow core slab comprising:

- steel bar cages made by coupling steel bars;
- doughnut-shaped hollow core bodies spacedly arranged in rows and columns in such a manner as to be restrained in the steel bar cages;
- slab lower steel bars arranged as main bars beneath the steel bar cages;
- slab upper steel bars arranged as main bars on the steel bar cages in a direction parallel to the slab lower steel bars; and
- slab concrete cast and cured to a thickness through which the slab lower and upper steel bars are buried,

wherein each steel bar cage comprises: first and second lower horizontal bars spaced apart from each other in parallel with each other; first and second upper horizontal bars spaced apart from each other with a width smaller than the first and second lower horizontal bars above the first and second lower horizontal bars; a first side tilt bars adapted to connect the first upper and lower horizontal bars to each other, while being inclined to each other along the lengthwise directions of the first upper and lower horizontal bars in such a manner where the inclined directions of the neighboring first side tilt bars are opposite to each other; second side tilt bars adapted to connect the second upper and lower horizontal bars to each other, while being inclined to each other along the lengthwise directions of the second upper and lower horizontal bars in such a manner where the inclined directions of the second side tilt bars are opposite to those of those of the first side tilt bars in

such a manner as to cross the first side tilt bars; upper tilt bars adapted to connect the first and second upper horizontal bars to each other, while being inclined to each other along the lengthwise directions of the first and second upper horizontal bars in such a manner as to connect the first and second side tilt bars facing each other; a first end tilt bar adapted to inclinedly connect one end portion of the first upper horizontal bar and one end portion of the second lower horizontal bar; and a second end tilt bar adapted to inclinedly connect the other end portion of the first upper horizontal bar and the other end portion of the second lower horizontal bar or to inclinedly connect the other end portion of the second upper horizontal bar and the other end portion of the first lower horizontal bar, and

each doughnut-shaped hollow core body comprises fitting slots formed correspondingly on both sides facing each other, into which the first and second side tilt bars are insertedly fitted, so that the hollow core bodies are inserted into the steel bar cages and the first and second side tilt bars are insertedly fitted to the fitting slots, thereby being restrained into the steel bar cages.

【Claim 9】

The bidirectional hollow core slab as defined in any one of claims 6 to 8, wherein the fitting slots of each doughnut-shaped hollow core body are formed in a shape of X corresponding to the arrangements of the first and second inclined portions of the first and second side bent bars or corresponding to the arrangement of the first and second side tilt bars.

【Claim 10】

A bidirectional hollow core slab comprising:

doughnut-shaped hollow core bodies spacedly arranged in rows and columns;

slab lower steel bars arranged as main bars and distributing bars beneath the doughnut-shaped hollow core bodies;

slab upper steel bars arranged as main bars and distributing bars on the doughnut-shaped hollow core bodies;

steel bar spacers disposed between the doughnut-shaped hollow core bodies and the distributing bars of the slab lower and upper steel bars; and

slab concrete cast and cured to a thickness through which the slab lower and upper steel bars are buried,

wherein each steel bar spacer comprises: a steel bar coupling piece formed to be welded or fitted to the distributing bars; and a protrusion formed to be fitted to each doughnut-shaped hollow core body, and

each doughnut-shaped hollow core body comprises fitting slots formed on the top and underside surfaces facing each other, so that the protrusions of the steel bar spacers are fitted to the fitting slots, thereby being restrained into the distributing bars.

【Claim 11】

A construction method of a bidirectional hollow core slab as defined in claims 6 or 7, comprising the steps of:

crossedly arranging main bars and distributing bars as slab lower steel bars;

disposing steel bar cages into which doughnut-shaped hollow core bodies are restrained on the main bars of the slab lower steel bars;

crossedly arranging distributing bars and main bars as slab upper steel bars on the steel bar cages; and

casting and curing slab concrete onto the slab lower and upper steel bars.

【Claim 12】

A construction method of a bidirectional hollow core slab as defined in claims 8, comprising the steps of:

crossedly arranging main bars as slab lower steel bars;

disposing steel bar cages into which doughnut-shaped hollow core bodies are restrained on the main bars of the slab lower steel bars, while first and second lower horizontal bars of the steel bar cages are being arranged to cross the main bars of the slab lower steel bars;

arranging main bars as slab upper steel bars on the steel bar cages, while the main bars of the slab upper steel bars are being arranged to cross first and second upper horizontal bars of the steel bar cages; and

casting and curing slab concrete onto the slab lower and upper steel bars.