

**DESCRIPTION****DECK PLATE SYSTEM HAVING CONTINUOUS HAUNCHED END PORTIONS  
USING CAP PLATE**

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**Technical Field**

The present invention relates generally to a deck plate system having continuous haunched end portions with a cap plate. More particularly, the present invention relates to a deck plate system having continuous haunched end portions with a cap plate, the system having deck plates, configured to be haunched, of which the end portions are bent, closed and reinforced, and the deck plates being applied to the deck plate system having the continuous end portions so as to reduce positive moment, thereby eliminating the need for the installation of shores during construction, forming a very efficient cross section after combining, effectively resisting the gaping and transverse torsion of the deck plates during construction, and ensuring increased bending strength.

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**Background Art**

In general, as a structure of tall building, a steel frame structure or a steel reinforced concrete structure that has good durability and good aseismicity is widely used. In the tall building using a steel frame structure or a steel

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reinforced concrete structure, a deck plate is generally used for the floor slab system in order to reduce construction period and to reduce labor cost.

The deck plate has two kinds: for formwork; and for  
5 structure. The formwork deck plate serves to bear the self-load of the concrete in a sludgy state during casting and the working load during construction, and after the concrete is cast, the floor load is supported by the steel reinforced concrete floor. The structural deck plate moves along with the  
10 steel reinforced concrete even after the concrete is cast, and serves to support the working load and has the same function as the tensile reinforcing bar. The structural deck plate has an effect similar to adding a reinforcing bar resisting flexural moment, thereby reducing the quantity of the reinforcing bar  
15 and the thickness of the concrete.

The examples of the structural deck plate are a reinforcing bar truss deck plate, a composite deck plate, and the like. The reinforcing bar truss deck plate is configured by integrating a structural member configured such that a  
20 portion of the reinforcing bar that is used for floor slab is formed to be in a truss shape with a flat-type formwork deck plate (a flat deck plate), and the reinforcing bar truss deck plate is configured to bear erection load by the reinforcing bar truss, thereby reducing the thickness of the deck plate,  
25 and reducing the entire height of the floor slab by eliminating

corrugations for composition. A variety of reinforcing bar truss deck plates have been developed depending on a shape of the reinforcing bar truss.

Korean Patent No. 10-1028372 is a document of related art  
5 of the present invention.

The related art disclosed a connected structure of truss assembled deck plates including: a base plate made of a steel plate; and truss girders fixedly mounted on the base plate, wherein the base plate is placed at the two sides of the upper  
10 end of a horizontal beam mold; lower reinforced connecting nets are fitted between the lower reinforced members of the deck plate; the lower reinforced connecting nets are combined with the lower reinforced member by wires; and the upper reinforced connecting nets are combined with the upper reinforced member  
15 of the deck plate. When the truss assembled deck plate is connected in a manner described above, it is possible to simultaneously connect a plurality of upper reinforcing bars and lower reinforcing bars together, thus facilitating construction by reducing working hours. A connected structure  
20 of truss assembled deck plates is provided to connect upper and lower reinforced members simultaneously and to reduce working time by using lower and upper reinforced connecting nets.

However, in the related art, the composite deck plate is integrally combined with the slab concrete to support the load,  
25 which has a cross sectional shape with continuous open-

corrugations and is formed with embossing or a groove thereon to improve composition effect. The conventional deck plate is configured such that the end thereof is simply supported by the beam. In other words, the deck plate does not have the  
5 continuous end thereof, and thus has inefficient structure. When the deck plate is applied with a long span of more than 5m, shores are required to support the deck plate during construction due to the excessive positive moment. Further, the open-corrugations may gap due to the lateral pressure when  
10 pouring the concrete or by the lateral force during construction, or transverse torsion may be generated.

## **Disclosure**

### **Technical Problem**

15 Accordingly, the present invention has been made keeping in mind the above problems occurring in the related art, and the present invention is intended to propose a deck plate system having continuous haunched end portions with a cap plate, the system having deck plates, configured to be haunched and  
20 end portions to be bent, closed, and reinforced. The deck plates being applied to the deck plate system having the continuous end portions so as to reduce positive moment, thereby eliminating the need for the installation of shores during construction, forming a very efficient cross section  
25 after combining, effectively resisting the gapping and

transverse torsion of the deck plates during construction, and ensuring increased bending strength.

#### **Technical Solution**

5        In order to achieve the above object, according to an embodiment of the present invention, there is provided a deck plate system having continuous haunched end portions with a cap plate, the deck plate system including: a deck plate body having a cross-section with a plurality of parallel open ribs  
10 that are separated from each other by a flat part, the deck plate body having a predetermined width; a negative moment reinforcing cap plate, the cap plate being placed at a location spaced at a predetermined distance from an end of the deck plate body and including: a cover part for closing an  
15 associated open rib at opposite end portions thereof in a longitudinal direction of the deck plate body, and a coupling part (132) horizontally extending from the opposite end portions of the cover part and being seated on and coupled to the flat part; and a truss-type prefabricated reinforcing bar  
20 (14) placed in a lateral direction of the deck plate body so as to connect the flat parts together, wherein the deck plate body is configured such that opposite end portions thereof in a longitudinal direction are integrally provided with respective end-reinforcing bent plates that each include: top-reinforcing  
25 bent parts provided by downwardly bending a predetermined

section from an end portion of the flat part at a predetermined angle so as to prevent cast-in-place concrete from intruding and to close and reinforce a cross-section of the end of the flat part, and a side-reinforcing bent parts provided by  
5 bending lateral sides of each of the open ribs to be overlapped on the top-reinforcing bent parts; and each of the open ribs is configured such that a bottom surface thereof is provided with a dovetail groove, and end coupling parts having a shape in which a dovetail rib defining the dovetail groove is vertically  
10 divided in half are used to lap-splice end portions of a deck plate and an adjacent deck plate in lateral directions of the deck plates.

In order to achieve the above object, according to another embodiment of the present invention, there is provided a deck  
15 plate system having continuous haunched end portions with a cap plate, the deck plate system including: a deck plate body having a cross-section with a plurality of parallel open ribs that are separated from each other by a flat part, the deck plate body having a predetermined width; a negative moment  
20 reinforcing cap plate, the cap plate being placed at a location spaced at a predetermined distance from an end of the deck plate body and including: a cover part for closing an associated open rib at opposite end portions thereof in a longitudinal direction of the deck plate body, and a coupling  
25 part horizontally extending from the opposite end portions of

the cover part and being seated on and coupled to the flat part; and a truss-type prefabricated reinforcing bar placed in a lateral direction of the deck plate body so as to connect the flat parts together, wherein a deck plate and an adjacent deck plate both being disposed on an upper surface of a beam are connected to each other by extending the cap plate; the deck plate body is configured such that opposite end portions thereof in a longitudinal direction are integrally provided with respective end-reinforcing bent plates each including:

5 top-reinforcing bent parts provided by downwardly bending a predetermined section from an end portion of the flat part at a predetermined angle so as to prevent cast-in-place concrete from intruding and to close and reinforce a cross-section of the end of the flat part, and a side-reinforcing bent parts

10 provided by bending lateral sides of each of the open ribs to be overlapped on the top-reinforcing bent parts; and each of the open ribs is configured such that a bottom surface thereof is provided with a dovetail groove, and end coupling parts having a shape in which a dovetail rib defining the dovetail

15 groove is vertically divided in half are used to lap-splice end portions of the neighboring deck plates in lateral directions of the deck plates.

Further, the negative moment reinforcing cap plate may include a cut-off groove provided between the cover part and

25 the coupling part by being grooved so as to be engaged with the

associated open rib; and the cut-off groove may be seated on a stop protrusion provided on the side surface of the deck plate body.

Further, the flat part may be provided with respective  
5 connecting depressions on centers thereof, the connecting depressions being spaced at predetermined intervals; and the truss-type prefabricated reinforcing bar may be provided with connectors at a lower portion thereof, the connectors being spaced at predetermined intervals, whereby the connectors are  
10 seated in and engaged with the respective connecting depressions of the flat part.

The deck plate system may further include a connecting bar seated on and engaged with a connecting bar groove that is provided on the cover part, thereby allowing the cap plates for  
15 resisting negative moment of the neighboring deck plates disposed on the upper surface of the beam to be continuously connected to each other.

The deck plate system may further include a lower connection plate allowing bottom surfaces of the open ribs of  
20 the neighboring deck plates disposed on the upper surface of the beam to be continuously connected to each other.

Further, the lower connection plate may be slidingly engaged with the dovetail rib to overlap therewith by having a same cross-section as the dovetail rib.

25 Further, the cover part of the negative moment reinforcing

cap plate may be provided with a concrete pouring hole.

### **Advantageous Effects**

According to the present invention having the above-  
5 described characteristics, it is possible to effectively  
prevent buckling of the deck plate, which is formed by bending  
a thin plate, and prevent deformation, such as collapse,  
bulging, and warping, occurring when the concrete is cast,  
using a plurality of the cap plates. In particular, the  
10 present invention is capable of allowing the deck plate system  
to have continuous end portions by using a negative moment  
reinforcing cap plate, whereby it is possible to reduce  
positive moment generated from the center of the deck plate,  
thereby realizing the deck plate system having long span. Thus,  
15 shores are not required during construction.

Further, an end-reinforcing bent plate is integrally  
formed by haunch bending the deck plate at opposed cut surfaces,  
whereby it is possible to prevent cast-in-place concrete from  
intruding and to close and reinforce a cross section thereof,  
20 and further it is possible to improve workability by closing  
open end portions because an additional formwork is not  
required when constructing the slab.

### **Description of Drawings**

25 The above and other objects, features and advantages of

the present invention will be more clearly understood from the following detailed description when taken in conjunction with the accompanying drawings, in which:

FIG. 1 is a perspective view illustrating a deck plate  
5 according to the present invention;

FIG. 2a is a cross sectional view taken along line A-A of  
FIG. 1;

FIG. 2b is a cross sectional view taken along line B-B of  
FIG. 1;

10 FIGS. 3a, 3b, 3c, and 3d are perspective views  
illustrating a cap plate according to a variety of embodiments  
of the present invention;

FIG. 4 is a perspective view illustrating a hunched  
header-type deck plate system for continuously connecting sides  
15 of deck plates according to an embodiment of the present  
invention;

FIG. 5 is a perspective view illustrating a hunched  
header-type deck plate system for continuously connecting sides  
of deck plates according to another embodiment of the present  
20 invention;

FIG. 6 is a front view of a haunch apparatus for a deck  
plate according to the present invention, illustrating a state  
where a carriage is transferred to a cutting location;

FIG. 7 is a plane view of FIG. 6;

25 FIG. 8 is a side view of FIG. 6;

FIG. 9 is a partial enlarged view of FIG. 6;

FIG. 10 is a front view of the haunch apparatus for a deck plate according to the present invention, illustrating a state where a carriage is transferred to a haunch bending location;

5        FIG. 11 is a side view illustrating a deck plate transfer clamp unit of FIG. 6;

FIG. 12 is a view illustrating a state where a deck plate haunch clamp unit and an upper die of FIG. 6 are separated from each other;

10        FIG. 13 is a schematic perspective view illustrating components for haunching the deck plate of FIG. 10;

FIG. 14 is a perspective view illustrating the cutting location and a state where the deck plate is bent at the haunch bending location of FIG. 13;

15        FIG. 15 is a perspective view illustrating the deck plate that is completely formed; and

FIG. 16 is a perspective view illustrating the deck plate that is completely haunched.

## 20    **Best Mode**

Reference will now be made in greater detail to an exemplary embodiment of the present invention, an example of which is illustrated in the accompanying drawings. However, it should be understood that the embodiment of the present  
25    invention may be changed to a variety of embodiments and the

scope and spirit of the present invention are not limited to the embodiment described hereinbelow.

FIG. 1 is a perspective view illustrating a deck plate according to the present invention; and FIG. 2 is a cross  
5 sectional view of FIG. 1.

As shown in FIGS. 1 and 2, the deck plate 10 according to the present invention is configured such that a deck plate body 11 is coupled to a negative moment reinforcing cap plate 13 so as to obtain the continuity of end portions, and is configured  
10 such that a truss-type prefabricated reinforcing bar 14 connects flat parts 111 to each other so as to connect open ribs 121 and adjacent open ribs together in a lateral direction of the deck plate body 11, and to close the open ribs. Thereby, when concrete is poured, the gapping of the open ribs 121 and  
15 the transverse torsion of the deck plate 10 are prevented, and thus it is possible to effectively resist the external force (particularly, flexural moment). Further, by converting an open cross-section into a closed cross-section, it is possible to secure the shape of the deck plate and to obtain the  
20 continuity of end portions.

Further, as shown in FIGS. 1 and 16, opposite ends in a longitudinal direction the deck plate body 11 are integrally provided with an end-reinforcing bent plate 125 so as to prevent cast-in-place concrete from intruding and to close and  
25 reinforce a cross section thereof.

In the present invention, the deck plate body 11 includes a flat part 111 and two sloping lateral sides 121a extending from the flat part 111, and has a cross section with a plurality of parallel open ribs 121 that are separated from each other by flat part 111 by interconnecting the two neighboring deck plate bodies 11 in a lateral direction of the deck plate body using an end coupling part 121e. The open rib 121 and the adjacent open rib 121 have a gap between the lateral sides 121a, wherein the gap may be wider than the bottom surface 121b. Thus, the open rib 121 includes the bottom surface 121b, the lateral sides 121a, and an open upper surface between the neighboring flat parts 111.

The deck plate body 11 configured as described above may have a predetermined width, and may be interconnected with the adjacent deck plate body 11 in lateral directions of the deck plates by overlapping the facing sides. The bottom surface 121b of the open rib 121 is provided with a dovetail groove 121c for connecting hardware for installing the ceiling finishing material, and the end coupling part formed by vertically bisecting a dovetail rib 121d that defines the dovetail groove 121c is used for interconnecting sides of the neighboring deck plates by overlapping the facing sides. In the case where the dovetail groove 121c is not provided in the bottom surface 121b of the open rib 121, in other words, in the case where the end coupling part 121e configured as described

above is not provided, a process of bending the side of the deck plate for additionally overlapping the sides may be required, wherein the process of bending the side of the deck plate is publicly known in the art to which this invention  
5 belongs.

Meanwhile, in the above description, the deck plate body 11 includes a flat part 111 and two sloping lateral sides 121a and 121a extending from the flat part 111, and has a cross section with a plurality of parallel open ribs 121 that are  
10 separated from each other by flat part 111 by interconnecting the two neighboring deck plate bodies 11 in a lateral direction of the deck plate body using an end coupling part 121e. However, the deck plate body may have a cross section with a plurality of parallel open ribs 121 that are separated from each other by  
15 flat part 111 by bending a single steel plate, wherein rather than formed by overlapping the end coupling parts 121e, the dovetail rib 121d may be formed in the middle of bending the steel plate for forming the open ribs 121.

The flat part 111 and the open rib 121 of the deck plate  
20 body 11 may be provided with a means for enhancing adhesion, which is publicly known in the art to which this invention belongs, such as a locking rib or embossment, not shown in the drawings, so as to improve the composite effect between the deck plate and the concrete.

25 In the present invention, the height of the deck plate

body 11 is not limited, but preferably may range from 140mm to 250mm. In the case where the height of the deck plate body 11 is less than 140mm, the deck plate, as a thin deck plate, is used for a span less than 4m, and is used as a composite deck plate by disposing a truss bar.

In the case where the span is more than 5m, the deck plate is used for formwork. In the case where the span is more than 6m, the deck plate is used by using shores due to the instability of the shape comparing to the rigidity thereof or the deformation during construction. Here, in the case where the height of the deck plate body 11 is more than 250mm, the application of the deck plate may be limited due to the relation between the beam and the deck plate.

Further, as shown in FIGS. 1 and 16, the deck plate body 11 is configured such that opposite ends in a longitudinal direction thereof are integrally provided with a end-reinforcing bent plate 125. The end-reinforcing bent plate 125 is provided to prevent cast-in-place concrete from intruding and to close and reinforce a cross section thereof while constructing slab. The end-reinforcing bent plate 125 includes: an top-reinforcing bent parts 125a provided by downwardly bending a predetermined section of an end of the flat part 111 at a predetermined angle: and a side-reinforcing bent parts 125b provided by bending lateral sides 121a of each of the open ribs 121 to overlap with the top-reinforcing bent

parts 125a.

As described above, the deck plate body 11 is configured such that the cross section is closed by the end-reinforcing bent plate 125 provided at the opposite ends thereof, such that  
5 the cast-in-place concrete is prevented from intruding into the opposite ends while constructing a slab. Further, the end-reinforcing bent plate 125 is configured such that the top-reinforcing bent parts 125a and the side-reinforcing bent parts 125b are permanently bent to show the rigidity, and thereby  
10 resistance to the transverse torsion of the deck plate body 11 and bending resistance are increased, and thus it is possible to apply the deck plate to a long span structure.

The deck plate body 11 described above has a structure, which is the same as or similar to a corrugated deck plate  
15 mainly used for formwork, or a deep deck plate for composition. The present invention may be applied to an unpredetermined deck plate, which is publicly known in the art to which this invention belongs and has a cross-section with a plurality of parallel open ribs 121 that are separated from each other by  
20 flat part 111, regardless of the height and the shape of the open rib including the corrugated deck plate and the deep deck plate.

The open ribs 121 of the deck plate body 11 are connected by the negative moment reinforcing cap plate 13. The opposite  
25 ends of the longitudinal direction of the deck plate body 11

are respectively provided with the negative moment reinforcing cap plate 13. The negative moment reinforcing cap plate 13 is placed at a location spaced apart at a predetermined distance from an end of the deck plate body 11.

5        The cap plate 13 is for resisting the negative moment exerted on the deck plate body 11 during construction, and for obtaining the continuity of end of the deck plate body 11, wherein the cap plate is coupled to connect the upper surface of the open ribs 121 at the opposite ends of the longitudinal  
10        direction of the deck plate body 11. Thus, the negative moment reinforcing cap plate 13 closes the associated open rib 121 at an end of the deck plate body 11. The length of the cap plate 13 may be determined based on the length of the interval on which the negative moment is exerted when the deck plate body  
15        11 is continuously connected. It is preferred that the length of the cap plate is  $1/6$  to  $1/10$  of the entire length  $L$  of the deck plate body 11. The cross section of the cap plate 13 is not limited to a predetermined shape. The cap plate may have enough rigidity and strength to connect the neighboring deck  
20        plate bodies 11 together on the beam while preventing gapping of the open ribs 121 and resisting the transverse torsion of the deck plate 10.

      The negative moment reinforcing cap plate 13 may include:  
      a cover part 131 for closing an associated open rib 121 by  
25        being made of a steel plate having a predetermined even

thickness; and a coupling part 132 horizontally extending from the opposite sides of the cover part 131 and being seated on and coupled to the flat part 111 by bending a corrugated steel plate.

5       As shown in FIG. 3, a cut-off groove 13c may be provided between the cover part 131 and the coupling part 132 by being grooved so as to be engaged with the associated open rib 121; and a stop protrusion 121f may be provided with the lateral sides 121a of the deck plate body 11 such that the cut-off  
10       groove 13c is seated on the stop protrusion 121f.

      The cut-off groove 13c is provided between the cover part 131 and the coupling part 132 by being grooved. From a top view, the cut-off groove is formed to be a groove, and, from a bottom view, it is formed to be a protrusion, wherein the cut-  
15       off groove is contact with and engaged with the lateral sides of the open rib 121.

      The pressure exerted on the cover part 131 of the cap plate 13 is transferred to the coupling part 132, and the coupling part 132 is coupled to the flat part 111 of the deck  
20       plate body 11, whereby the flat part 111 may be deformed by the pressure transferred from the coupling part. When the cut-off groove 13c is provided, the pressure exerted on the cover part 131 of the cap plate 13 is transferred to the coupling part 132, but the cut-off groove 13c cuts off the pressure, and thus it  
25       is possible to prevent the deformation of flat part 111 by the

pressure.

The cover part 131 is provided with a connecting bar groove 133. As shown in FIGS. 3a and 3c, the connecting bar groove 133 may be provided on the upper surface of the cover part 131 such that a connecting bar 30 is seated and welded on the connecting bar groove 133. Alternatively, as shown in FIGS. 3b and 3d, the connecting bar groove 133 may be provided on the rear surface of the cover part 131 such that a connecting bar 30 is seated and welded on the connecting bar groove 133.

The connecting bar groove 133 is formed in such a way that the connecting bar 30 is securely and regularly arranged thereon when the connecting bar 30 is arranged, and thereby the connecting bar 30 is prevented from being separated from the negative moment reinforcing cap plate 13.

The coupling part 132 is seated on the upper portion of the flat part 111, and an unpredetermined method, which is publicly known in the art to which this invention belongs, such as welding, a screwed joint, a bolted joint, clinching, and the like, may be applied thereto.

As shown in FIGS. 3a and 3b, the cover part 131 may include a flat upper surface with sloping surfaces at opposite sides thereof. Alternatively, as shown in FIGS. 3c and 3d, the cover part 131 may include a flat upper surface with small sloping surfaces or without sloping surfaces at opposite sides thereof; and the cover part 131 may include a plurality of

concrete pouring holes 131a provided on the upper surface thereof such that the concrete is poured to the open ribs 121 to be tightly cast, and such that the concrete is integrally composed of the truss-type prefabricated reinforcing bar 14 not  
5 being separated therefrom.

The truss-type prefabricated reinforcing bars 14 are spaced apart from each other in a lateral direction of the deck plate body 11 and coupled to the flat parts 111 so as to connect the open upper surfaces of the open ribs 121 to each  
10 other.

The truss-type prefabricated reinforcing bar 14 is not limited to a predetermined shape, and should have sufficient rigidity and strength to connect the open upper surfaces of the open ribs 121 and to resist the gaping and transverse torsion  
15 of the deck plate so as to connect the open ribs 121 of the deck plate body 11 to each other, wherein the truss-type prefabricated reinforcing bar may be a triangular, a quadrangular, or a linear shape, such as a three dimensional truss-type.

20 Thus, the truss-type prefabricated reinforcing bar 14 may be selected among many kinds of truss-shaped reinforcing bars, such as a Kaiser Truss.

The truss-type prefabricated reinforcing bar 14 serves to resist the gapping of the open ribs 121 or distribute the  
25 working load loaded to an unpredetermined location to the open

ribs 121 of the adjacent deck plate.

The truss-type prefabricated reinforcing bar 14 is manufactured in a manner where a portion of the reinforcing bar is formed to be truss-type, and then integrally mounted to the flat-type deck plate body 11, such that the erection load is distributed by the truss-type prefabricated reinforcing bar 14, and thereby it is possible to reduce the thickness of the deck plate, and also possible to reduce the thickness of the entire bottom structure.

The flat part 111 of the deck plate body 11 is provided with connecting depressions 111b on the center thereof in a longitudinal direction, wherein the connecting depressions 111b are formed to correspond to connectors 145 of the truss-type prefabricated reinforcing bar 14.

The truss-type prefabricated reinforcing bar 14 is provided with the connectors 145 at a lower portion thereof, the connectors being spaced at predetermined intervals, whereby the connectors 145 are seated in and engaged with the connecting depressions 111b of the flat part 111. The connector 145 may be configured to be in a variety of shapes, such as a box shape or a channel shape with an open bottom surface. The deck plate body 11 and the truss-type prefabricated reinforcing bar 14 may be coupled to each other by a variety of manners publicly known, such as welding, a screwed joint, a bolted joint, clinching, and the like.

As shown in FIGS. 3a, 3b, 3c, and 3d, the cover part 131 of the negative moment reinforcing cap plate 13 protrudes upwardly, but is not limited thereto in the present invention, so the cover part may protrude downwardly or may be in a flat shape. In the case of protruding downwardly, it is advantageous in that the height of the slab concrete is reduced; in the case of protruding upwardly, it is advantageous in that the cover part is effectively combined to the slab concrete. Further, if it is possible to effectively reinforce the deck plate body 11 to resist the load during construction, the cover part may be configured to be in a flat shape having a predetermined thickness.

The deck plate 10 having the cap plate according to the present invention configured as described above may effectively prevent buckling of the deck plate, which is formed by bending a thin plate, and prevent deformation, such as collapse, bulging, and warping, occurring when the concrete is cast, using a plurality of the cap plates.

Hereinbelow, reference will be made to the deck plate system having continuous haunched end portions with the cap plate configured as described above.

FIG. 4 is a perspective view illustrating the deck plate system having continuous haunched end portions according to an embodiment of the present invention.

As shown in FIG. 4, the deck plate system is configured to

be disposed on each opposite end of the beam 200 in a lateral direction of the beam, wherein the deck plate system includes: the deck plate 10 having the cap plate configured as described above, which is supported by the beam 200; and a connecting bar  
5 30 connecting the negative moment reinforcing cap plates of the deck plate and the adjacent deck plate 10 both disposed on the upper surface of the beam 200 to have continuous end portions, and the deck plate system may further include a lower connection plate 33 connecting the bottom surfaces 121b of the  
10 open ribs 121 of the neighboring deck plates 10, which are disposed on the upper surface of the beam, to have continuous end portions.

The kind of the beam 200 to which the present invention is applied is not limited, and the present invention is applied to  
15 a unpredetermined beam, such as a cast-in-place concrete beam, a precast concrete beam, a steel beam, a composite beam, and the like, which are publicly known in the art to which this invention belongs.

The connecting bar 30 is disposed across the beam 200, and  
20 connects the negative moment reinforcing cap plates 13 of the neighboring deck plates 10 so as to continue the neighboring deck plates 10 disposed on the upper surface of the beam 200. In the accompanying drawings, two connecting bars 30 are mounted, but this is merely an example, thus the number of the  
25 connecting bars 30 is not limited thereto.

The connecting bar 30 may be made of a variety of materials, for example, a reinforcing bar, a steel bar, a flat bar, and so on.

In the case where the dovetail groove 121c is formed on the bottom surface 121b of the open ribs 121, dovetail ribs 121d of the neighboring deck plate bodies 11 are connected to each other by using a lower connection plate 33. The lower connection plate 33 has the same cross sectional shape as the dovetail rib 121d but has a larger cross section size than the dovetail rib so as to be slidably engaged with the dovetail rib. In the case where the dovetail groove 121c is formed on the deck plate body 11, the lower connection plate 33 may be in a planar shape, and may be in a shape connecting the bottom surfaces 121b of the open ribs 121 together.

Thus, in the present invention, the ends of the deck plates 10 are configured such that the upper portions thereof are connected to each other by the connecting bar 30, and the lower portions thereof are connected to each other by the lower connection plate 33 to be continuous.

FIG. 5 is a perspective view illustrating the deck plate system having continuous haunched end portions according to another embodiment of the present invention.

As shown in FIG. 5, the deck plate 10, which is disposed on the beam 200 and supported by the beam 200, the neighboring deck plates 10 disposed at opposite ends of the beam may be

connected to each other by extending the negative moment reinforcing cap plate 13, rather than being connected by using the connecting bar 30. In the case of extending the negative moment reinforcing cap plate, the negative moment reinforcing cap plate 13 may be coupled to connect the neighboring deck plates 10 in the work place after the deck plates 10 are disposed on the beam.

As described above, the deck plate system having continuous end portions according to the present invention is capable of effectively resisting negative moment by using the negative moment reinforcing cap plate, and capable of continuing the deck plates, thereby reducing positive moment generated from the center of the deck plate, and thus the present invention is advantageous in that shores are not required during construction.

Meanwhile, in the deck plate body 11, reference will be made to an apparatus according to an embodiment for manufacturing the haunched deck plate, as a basic module for having an end-reinforcing bent plate 125.

A haunch apparatus for deck plate according to the present invention is a manufacturing apparatus that permanently bends the end portion of the deck plate 5, as shown in FIG. 15, which is formed in a process where the steel plate shown in FIG. 10 is firstly formed by a forming device that is publicly known and is not shown in the accompanying drawings, so as to form

the end-reinforcing bent plate 125 that closes the cross section in a longitudinal direction of the deck plate as shown in FIG. 16.

Firstly, as shown in FIGS. 6 to 8, a bed 12a is disposed in a transfer direction of the deck plate 5 completely formed and fixedly mounted to the installation floor.

The bed 12a is provided with a carriage 14a. The carriage 14a is slidably engaged with the bed 12a to move forward and backward in a transfer direction of the deck plate 5. The carriage 14a is configured to slidably move along a linear guide 15 provided on the upper surface of the bed 12a.

A fixed lower die 16 and a movable lower die 18 are mounted to the upper surface of the carriage 14a. The fixed lower die 16 and the movable lower die 18 are aligned along a transfer direction of the deck plate 5 to face each other. Here, in the apparatus, the fixed lower die 16 is placed at a location from which the deck plate is introduced; and the movable lower die 18 is placed at a location to which the deck plate is discharged. The fixed lower die 16 and the movable lower die 18 respectively have the same cross sectional shape as the deck plate 5, and have respective haunched sloping surfaces 161 and 181 that face each other, and are tilted having the same tilt angle  $\theta$ . Here, the tilt angle  $\theta$  ranges from  $30^\circ$  to  $60^\circ$ , and according to the embodiment, the tilt angle  $\theta$  is set as  $45^\circ$ . The reason why the fixed lower die 16

and the movable lower die 18 are provided in the present invention is to simultaneously bend the opposed ends of the cut surface of the deck plate.

Herein, the movable lower die 18 is mounted to move up and  
5 down in a vertical direction, and is connected to an up-and-down cylinder 19, which is fixedly provided in the carriage 14a, so as to move downwardly after completion of haunching (bending) the deck plate 5. The up-and-down cylinder 19 is provided to move the movable lower die 18 down after completion  
10 of haunching (bending) the deck plate 5 such that the deck plate 5 is discharged to a side of the carriage 14a (the right side of the carriage in the drawings).

The bed 12a is provided with a deck plate transfer clamp unit 20 at a fore end thereof (an end to which the deck plate  
15 is discharged). The deck plate transfer clamp unit 20 serves to clamp an end of the deck plate 5, which is completely transferred to the fixed lower die 16 and the movable lower die 18, so as to allow the deck plate to be haunch.

The deck plate transfer clamp unit 20 includes: a lower  
20 support 21 provided on an upper surface of a side of the bed 12; a pair of guide shafts 22 vertically provided on an upper surface of the lower support 21; a cylinder support 24 provided at an upper portion of the guide shafts 22; a transfer clamp cylinder 26 vertically provided in the cylinder support 24; and  
25 a stopper 28 slidably engaged with the pair of guide shafts 22

to be connected to an operating rod of the transfer clamp cylinder 26. Thus, when the transfer clamp cylinder 26 is moved down, the reversed U-shape stopper 28 locks the deck plate by clamping opposite wings of the deck plate 5 at  
5 opposite ends thereof.

The carriage 14a is provided with a deck plate cutting unit 30a at a rear end thereof (an end to which the deck plate is introduced). The deck plate cutting unit 30a moves the carriage 14a backwards so as to cut a second end of the deck  
10 plate 5 (an end opposite to a fixed end to form two cut surfaces divided into two parts).

As shown in FIG. 9, the deck plate cutting unit 30a includes: a cutter housing 32 with a hole for accommodating the cross sectional shape of the deck plate 5; a deck plate cutter  
15 34 provided within the cutter housing 32; a pair of cutting cylinders 36 supported by the carriage 14a and allowing the deck plate cutter 34 to have a cutting force; and a cutter return spring 38 provided within the cutter housing 32 and allowing the deck plate cutter 34 to go back to an original  
20 position after cutting the deck plate. The pair of cutting cylinders 36 is vertically provided in an upper support plate 520, which will be described hereinbelow.

A carriage transfer cylinder 40 is provided as a means for transferring the carriage, which moves a haunch bending  
25 location of the carriage 14a to a cutting location Z. The

haunch bending location refers to a middle point between the upper die 574 and the lower dies 16 and 18. The carriage transfer cylinder 40 is configured such that the fixed end is connected to the bed 12a, and the operating rod is connected to the carriage 14a. Thus, the carriage transfer cylinder 40 moves the carriage 14a to the cutting location or to the haunch bending location. In other words, as shown in FIG. 6, the carriage transfer cylinder 40 determines the cutting location of the deck plate cutting unit 30a by moving the carriage 14a forward in a discharging direction. Then, as shown in FIG. 9, the carriage transfer cylinder 40 determines a location for haunch bending by moving the carriage 14a backwards (an introduction direction or a forming direction) such that the cut surface of the deck plate 5 is placed between the fixed lower die 16 and the movable lower die 18.

The carriage 14a is provided with an upper haunch hydraulic assembly 50 at an upper portion thereof. The upper haunch hydraulic assembly 50 locks the deck plate 5 that reaches the haunch bending location, and then firstly and secondarily bends the opposed cut surfaces to form the closed end.

The upper haunch hydraulic assembly 50 is provided at an upper portion of a plurality of vertical supports 17 that are vertically provided in the carriage 14a, and the upper haunch hydraulic assembly 50 includes: an upper support plate 520

supported at a predetermined height from the carriage 14a; a deck plate haunch clamp unit 540 provided in the upper support plate 520, and clamping the deck plate 5 that reaches the haunch bending location; a side bending unit 560 firstly  
5 bending opposite sides 5a of the cut surfaces of the deck plate 5 by moving in a direction perpendicular to a transfer direction of the deck plate after the deck plate haunch clamp unit 540 clamps the deck plate; and a top plate bending unit 570 secondarily bending a top plate 5b of the cut surface of  
10 the deck plate 5 downwardly.

As shown in FIG. 9, the deck plate haunch clamp unit 540 includes: a pair of vertical haunch clamp cylinders 542 vertically provided in the upper support plate 520; and a haunch clamp block 546 connected to an operating rod of the  
15 pair of vertical haunch clamp cylinders 542 to engage the fixed lower die 16 with the movable lower die 18, thereby clamping the deck plate 5 that reaches the haunch bending location. Here, a lower portion of the haunch clamp block 546 is configured to be a groove opened downwardly corresponding to  
20 the cross sectional shape of the deck plate.

As shown in FIGS. 13 and 14, the side bending unit 560 includes: a pair of side haunch cylinders 562 fixedly provided to face each other on opposite side surfaces of the haunch clamp block 546 of the deck plate haunch clamp unit 540; and a  
25 side pusher 564 connected to operating rods of the pair of side

haunch cylinders 562 so as to move forward and backwards. Here, the side pusher 564 is disposed on a side surface of the deck plate.

The top plate bending unit 570 includes: a top plate  
5 haunch cylinder 572 vertically provided in the center of the upper support plate 520; and an upper die 574 connected to the operating rod of the top plate haunch cylinder 572 to bend the top plates of the cut surfaces of the deck plate when the upper die moves down. Here, the top plate haunch cylinder 572  
10 is disposed between the pair of vertical haunch clamp cylinder 542. The upper die 574 is disposed in the center of the haunch clamp block 546 so as to move up and down. As shown in FIG. 9, the upper die 574 has a haunch sloping surface 574a formed at each side thereof to have the same tilt angle as the tilt angle  
15  $\theta$  of the fixed lower die 16 and the movable lower die 18.

In the embodiment of the present invention, a hydraulic pump system for operation of various cylinders and a sensor for controlling operating sections of the respective cylinders are provided. Reference to a configuration of the hydraulic pump  
20 system and installation of the sensor, which is for controlling cylinder and is publicly known in the art to which this invention belongs, will be omitted.

Reference will now be made to an operational state of haunching the deck plate according to the embodiment configured  
25 as described above.

### Forward Movement of Carriage

Firstly, as shown in FIG. 6, the operating rod extends by the carriage transfer cylinder 40 such that the carriage 14a moves forward in a direction where the deck plate is discharged, whereby the deck plate cutting unit 30a is in the standby status at the cutting location Z beside the bed 12a.

Here, after the upper haunch hydraulic assembly 50 moves along with the carriage 14a, the haunch clamp block 546 and the upper die 574 are completely moved upward by the upward movement of the pair of vertical haunch clamp cylinders 542 and the top plate haunch cylinder 572. Thus, the deck plate is allowed to enter between the lower dies 16 and 18 and the upper die 574.

In the above state, as shown in FIG. 10, the formed deck plate 5 is transferred, and the fore end thereof passes by the carriage 14a, and thereby the deck plate is clamped by the deck plate transfer clamp unit 20. In other words, the stopper 28 moves downwards by the operation of the transfer clamp cylinder 26, and clamps the deck plate 5.

### Cutting of Deck Plate

Next, the deck plate is cut by the operation of the deck plate cutting unit 30a. To achieve this, the deck plate cutter 34 is pressed and operated by downward movement of the pair of cutting cylinders 36. Thus, as shown in FIG. 13, the deck plate has the cut surfaces by being divided into two parts

having a predetermined length.

#### Backward Movement of Carriage

Next, as shown in FIG. 10, the carriage 14a moves backward in a direction where the deck plate is introduced by the operation of the carriage transfer cylinder 40. Thus, a central axis of the top plate haunch cylinder 572 is placed at the cutting location Z, and thereby as shown in FIG. 9, the cut surfaces of the deck plate 5 are placed between the fixed lower die 16 and the movable lower die 18. In other words, the cut surfaces of the deck plate 5 reaches the haunch bending location.

#### Clamping of Deck Plate

Next, the pair of vertical haunch clamp cylinders 542 moves downward. Thus, the haunch clamp block 546 connected to the vertical haunch clamp cylinders 542 moves downward, and is engaged with the fixed lower die 16 and the movable lower die 18, thereby clamping the deck plate 5.

#### Side Haunch Bending

Next, the pair of side haunch cylinders 562 that face each other move forward. Thus, as shown in FIG. 13, the side pusher 564 connected to the operating rods of the pair of side haunch cylinders 562) moves to a transfer axis of the deck plate such that opposite sides of the cut surfaces of the deck plate are firstly bent to form side-reinforcing bent parts 125b. Then, the side haunch cylinders 562 move backwards so the side pusher

564 goes back to the original position thereof.

#### Top Plate Haunch Bending

Next, the upper die 574 moves downwards to be engaged with the fixed lower die 16 and the movable lower die 18 by the operation of the top plate haunch cylinder 572. Thereby, the top plates of the cut surfaces of the deck plate are secondarily bent downwards, as shown in FIG. 16, to form top-reinforcing bent parts 125a. After bending the top plates, the upper die 574 is raised to go back to an original position thereof by the reverse operation of the top plate haunch cylinder 572. Then, the vertical haunch clamp cylinder 542 is reversely operated such that the haunch clamp block 546 is raised to go back to an original position thereof and the clamping force on the deck plate 5 is eliminated.

After haunch bending the sides and the top plates of the cut surfaces, as shown in FIGS. 1 and 16, the cut surfaces of the deck plate 5 are formed with end-reinforcing bent plates 125, which include the top-reinforcing bent parts 125a and the side-reinforcing bent parts 125b, to close the ends thereof. In other words, in the process of haunch bending the deck plate, the ends of the opposed cut surfaces are closed simultaneously.

#### Discharging Haunched Deck Plate

Next, the movable lower die 18 moves down by the operation of the movable lower die up-and-down cylinder 19. Thus, an obstacle to a direction, to which the deck plate 5 is

discharged, is eliminated. Then, the deck plate is transferred from the forming device for the deck plate, and the deck plate having haunch end portions is discharged to a discharging direction.

5        Then, the cycle described above is repeated to produce the deck plate having continuous and closed end portions. In other words, the deck plate having closed end portions is produced by the repetitive process of cutting the formed deck plate, haunch bending, and discharging the deck plate.

10        According to the present invention, the opposed cut surfaces of the deck plate, which is divided into two parts, are formed with the end-reinforcing bent plates 125, which close the ends thereof simultaneously. In particular, the end of the deck plate is provided with the closed top-reinforcing  
15 bent parts 125a and the side-reinforcing bent parts 125b to overlap each other at a portion thereof, thereby having a reinforced cross sectional structure, and thus the present invention has an improved stiffening force, and improved workability because the process of closing end portions when  
20 constructing the slab, which is required in the conventional deck plate system, is not required.

      Meanwhile, in the operation of the haunch apparatus, after, the upper die 574 may be firstly moved downwards, the side pusher 564 may be moved forward to form the end-reinforcing  
25 bent plate 125.

Although a preferred embodiment of the present invention has been described for illustrative purposes, those skilled in the art will appreciate that various modifications, additions and substitutions are possible, without departing from the scope and spirit of the invention as disclosed in the accompanying claims.

### **Industrial Applicability**

A deck plate system having continuous haunched end portions with a cap plate according to the present invention is capable of effectively preventing buckling of the deck plate, which is formed by bending a thin plate, and preventing deformation, such as collapse, bulging, and warping, occurring when concrete is cast, using a plurality of the cap plates. In particular, the deck plate system according to the present invention is capable of allowing the deck plate system to have continuous end portions by using a negative moment reinforcing cap plate, whereby it is possible to reduce positive moment generated from the center of the deck plate, thereby realizing the deck plate system having a long span. Thus, shores are not required during construction. Further, an end-reinforcing bent plate is integrally formed by haunch bending the deck plate at opposed cut surfaces, whereby it is possible to prevent cast-in-place concrete from intruding and to close and reinforce a cross section thereof, and further it is possible to improve

workability by closing open end portions because an additional formwork is not required when constructing the slab.

## CLAIMS

1. A deck plate system having continuous haunched end portions with a cap plate, the deck plate system comprising:

5 a deck plate body (11) having a cross-section with a plurality of parallel open ribs (121) that are separated from each other by a flat part (111), the deck plate body having a predetermined width;

a negative moment reinforcing cap plate (13), the cap  
10 plate being placed at a location spaced at a predetermined distance from an end of the deck plate body (11) and including:  
a cover part (131) for closing an associated open rib (121) at opposite end portions thereof in a longitudinal direction of the deck plate body (11), and a coupling part (132)  
15 horizontally extending from the opposite end portions of the cover part (131) and being seated on and coupled to the flat part (111); and

a truss-type prefabricated reinforcing bar (14) placed in a lateral direction of the deck plate body (11) so as to  
20 connect the flat parts (111) together, wherein

the deck plate body (11) is configured such that opposite end portions thereof in a longitudinal direction are integrally provided with respective end-reinforcing bent plates (125) each including: top-reinforcing bent parts (125a) provided by  
25 downwardly bending a predetermined section from an end portion

of the flat part (111) at a predetermined angle so as to prevent cast-in-place concrete from intruding and to close and reinforce a cross-section of the end of the flat part, and a side-reinforcing bent parts (125b) provided by bending lateral  
5 sides (121a) of each of the open ribs (121) to be overlapped on the top-reinforcing bent parts (125a); and

each of the open ribs (121) is configured such that a bottom surface thereof is provided with a dovetail groove (121c), and end coupling parts having a shape in which a  
10 dovetail rib (121d) defining the dovetail groove (121c) is vertically divided in half are used to lap-splice end portions of a deck plate and an adjacent deck plate in lateral directions of the deck plates.

15 2. A deck plate system having continuous haunched end portions with a cap plate, the deck plate system comprising:

a deck plate body (11) having a cross-section with a plurality of parallel open ribs (121) that are separated from each other by a flat part (111), the deck plate body having a  
20 predetermined width;

a negative moment reinforcing cap plate (13), the cap plate being placed at a location spaced at a predetermined distance from an end of the deck plate body (11) and including:  
a cover part (131) for closing an associated open rib (121) at  
25 opposite end portions thereof in a longitudinal direction of

the deck plate body (11), and a coupling part (132) horizontally extending from the opposite end portions of the cover part (131) and being seated on and coupled to the flat part (111); and

5        a truss-type prefabricated reinforcing bar (14) placed in a lateral direction of the deck plate body (11) so as to connect the flat parts (111) together, wherein

        a deck plate and an adjacent deck plate both being disposed on an upper surface of a beam are connected to each  
10    other by extending the cap plate (13);

        the deck plate body (11) is configured such that opposite end portions thereof in a longitudinal direction are integrally provided with respective end-reinforcing bent plates (125) each including: top-reinforcing bent parts (125a) provided by  
15    downwardly bending a predetermined section from an end portion of the flat part (111) at a predetermined angle so as to prevent cast-in-place concrete from intruding and to close and reinforce a cross-section of the end of the flat part, and a side-reinforcing bent parts (125b) provided by bending lateral  
20    sides (121a) of each of the open ribs (121) to be overlapped on the top-reinforcing bent parts (125a); and

        each of the open ribs (121) is configured such that a bottom surface thereof is provided with a dovetail groove (121c), and end coupling parts having a shape in which a  
25    dovetail rib (121d) defining the dovetail groove (121c) is

vertically divided in half are used to lap-splice end portions of a neighboring deck plates in lateral directions of the deck plates.

5           3. The deck plate system of claim 1, wherein

the negative moment reinforcing cap plate (13) includes a cut-off groove (13c) provided between the cover part (131) and the coupling part (132) by being grooved so as to be engaged with the associated open rib (121); and the cut-off groove  
10 (13c) is seated on a stop protrusion (121f) provided on the lateral sides (121a) of the deck plate body (11).

4. The deck plate system of claim 1 or 3, wherein

the flat parts (111) are provided with respective  
15 connecting depressions (111b) on centers thereof, the connecting depressions being spaced at predetermined intervals; and the truss-type prefabricated reinforcing bar (14) is provided with connectors (145) at a lower portion thereof, the connectors being spaced at predetermined intervals, whereby the  
20 connectors (145) are seated in and engaged with the respective connecting depressions (111b) of the flat part (111).

5. The deck plate system of claim 2, further comprising:

a connecting bar (30) seated on and engaged with a  
25 connecting bar groove (133) that is provided on the cover part

(131), thereby allowing the cap plates (13) for resisting negative moment of the neighboring deck plates disposed on the upper surface of the beam to be continuously connected to each other.

5

6. The deck plate system of claim 5, further comprising:

a lower connection plate (33) allowing bottom surfaces (121b) of the open ribs (121) of the neighboring deck plates disposed on the upper surface of the beam to be continuously  
10 connected to each other.

7. The deck plate system of claim 6, wherein

the lower connection plate (33) is slidably engaged with the dovetail rib (121d) to overlap therewith by having a same  
15 cross sectional shape as the dovetail rib.

8. The deck plate system of claim 1 or 3, wherein

the cover part (131) of the negative moment reinforcing cap plate (13) is provided with a concrete pouring hole (131a).