

DESCRIPTION

TITLE OF INVENTION: JOINT STRUCTURE AND METHOD FOR CONSTRUCTING JOINT STRUCTURE

5 TECHNICAL FIELD

[0001]

The present invention relates to a joint configuration and a method for constructing the joint configuration.

BACKGROUND ART

10 [0002]

For example, a beam end connection between an RC beam or a wall and a primary beam or between a primary beam and a secondary beam is designed as a rigid joint or a pin joint. In an example in which a primary beam is used as a support member and a rigid joint is formed, the top and bottom flanges of a secondary beam are welded or bolted to the primary beam, and the web of the secondary beam is bolted to the primary beam. When a pin joint is formed, the web of the secondary beam is bolted to fin plates (also referred to as shear plates or gusset plates) attached to the primary beam, and the top and bottom flanges of the secondary beam are not joined to the primary beam.

20 [0003]

In this regard, Non-Patent Literature 1 describes a composite structure in which beams and a floor slab are integrated using shear connectors under load conditions in which moments in joint portions are not reversed, such as in a gravity frame that does not bear a horizontal force or in a moment frame in which a horizontal force is small and antisymmetric bending does not occur. In this case, the top flanges of secondary beams are not directly joined to primary beams. However, since a tensile force is transmitted through reinforcing rebars in the floor slab, the rigidity of the joint portions can be easily increased. By increasing the rigidity of the joint portions, deflection of the beams and the bending moments at the centers of the beams are reduced. Therefore, the design margin can be increased, and the cross-sections of the beams can be further reduced.

CITATION LIST

NON-PATENT LITERATURE

[0004]

- Non-Patent Literature 1: EUROPEAN COMMITTEE FOR
5 STANDARDIZATION, "Eurocode 4: Design of composite steel and concrete
structures Part 1-1: General rules and rules for buildings," April 2009

SUMMARY OF THE INVENTION

PROBLEMS TO BE SOLVED BY THE INVENTION

10 [0005]

In such a joint configuration as described in Non-Patent Literature 1, for example, reinforcing rebars extending across a primary beam are used for allowing tensile forces, which act on top flanges of secondary beams joined to opposite sides of the primary beam, to be mutually transmitted. However, since these reinforcing
15 rebars cannot be placed until the arrangement of other rebars in sections close to both sides of the primary beam is completed, workability is disadvantageous. Moreover, when reinforcing rebars are further placed on top rebars of a slab, it may be difficult to obtain the required concrete cover thickness in some cases, depending on the floor slab structure or the slab thickness.

20 Moreover, in portions of a floor slab around joint portions between the primary and secondary beams, negative bending regions in which a tensile force acts on the floor slab are formed due to a vertical load supported by the slab. Although the reinforcing rebars in the floor slab resists the tensile force, the concrete has low resistance to the tensile force and is prone to cracking. In a conventional bar
25 arrangement in which reinforcing rebars are arranged in the axial direction of secondary beams, the reinforcing rebars contribute to the reinforcement of the joint portions but make limited contribution to the floor slab in the direction of the maximum deflection of the floor slab, resulting in insufficient effects in terms of prevention of deflection and cracking of the floor slab.

30 [0006]

Accordingly, it is an object of the invention to provide a joint configuration in which top flanges of secondary beams and a primary beam are joined together via a

concrete floor slab and which can have improved workability while the floor slab has a sufficient concrete cover thickness and to provide a joint configuration construction method with which cracking of the floor slab can be prevented.

5 MEANS FOR SOLVING THE PROBLEMS

[0007]

[1] A joint configuration including: a primary beam having an H-shaped cross section; first and second secondary beams each having an H-shaped cross section, each extending in a direction intersecting the primary beam, and having respective ends facing each other with the primary beam interposed therebetween; and first and second joint members that join webs of the respective first and second secondary beams to the primary beam, in which a concrete floor slab is constructed over the primary beam and the first and second secondary beams, top flanges of the respective first and second secondary beams are joined to the concrete floor slab and are not directly joined to the primary beam and the respective first and second joint members, and a reinforcing rebar embedded in concrete of the concrete floor slab is disposed without extending over both the first and second secondary beams.

[2] The joint configuration according to [1], in which at least a part of the reinforcing rebar extends in a direction oblique to an axial direction of the first and second secondary beams.

[3] A joint configuration including: a primary beam having an H-shaped cross section; first and second secondary beams each having an H-shaped cross section, each extending in a direction intersecting the primary beam, and having respective ends facing each other with the primary beam interposed therebetween; and first and second joint members that join webs of the respective first and second secondary beams to the primary beam, in which a concrete floor slab is constructed over the primary beam and the first and second secondary beams, top flanges of the respective first and second secondary beams are joined to the concrete floor slab and are not directly joined to the primary beam and the respective first and second joint members, and at least a part of a reinforcing rebar embedded in concrete of the concrete floor slab extends in a direction oblique to an axial direction of each of the first and second secondary beams.

[4] The joint configuration according to any one of [1] to [3], in which the reinforcing rebar has an end portion or a turned-back portion disposed above the primary beam.

5 [5] The joint configuration according to any one of [1] to [4], in which bottom flanges of the respective first and second secondary beams are joined to the primary beam or to the respective first and second joint members with metal touching or with bolts.

[6] The joint configuration according to any one of [1] to [5], further including a tension member that is engaged with each of the top flanges or webs of the
10 respective first and second secondary beams and passes through a through hole formed in a web of the primary beam.

[7] A joint configuration including: a primary beam having an H-shaped cross section; a secondary beam having an H-shaped cross section and extending in a direction intersecting the primary beam; and a joint member that joins a web of the
15 secondary beam to the primary beam, in which a concrete floor slab is constructed over the primary beam and the secondary beam, a top flange of the secondary beam is joined to the concrete floor slab and is not directly joined to the primary beam and the joint member, and the joint configuration further includes a tension member that is engaged with the top flange or web of the secondary beam and with a top flange
20 or web of the primary beam.

[8] A joint configuration including: a primary beam having an H-shaped cross section; first and second secondary beams each having an H-shaped cross section, each extending in a direction intersecting the primary beam, and having respective ends facing each other with the primary beam interposed therebetween; and first and
25 second joint members that join webs of the respective first and second secondary beams to the primary beam, in which a concrete floor slab is constructed over the primary beam and the first and second secondary beams, top flanges of the respective first and second secondary beams are joined to the concrete floor slab and are not directly joined to the primary beam and the respective first and second
30 joint members, and the joint configuration further comprises a tension member that is engaged with the top flanges or webs of the respective first and second secondary beams and passes through a through hole formed in a web of the primary beam.

[9] A method for constructing the joint configuration according to any one of [6] to [8], the method including introducing a tensile force to the tension member after concrete of the concrete floor slab is cured.

[0008]

5 According to the above aspects of the invention, in the joint configuration of joining the primary beam and the top flanges of the secondary beams via the concrete floor slab, the workability can be improved while the floor slab has a sufficient concrete cover thickness.

10 BRIEF DESCRIPTION OF DRAWINGS

[0009]

Fig. 1 depicts a joint configuration according to a first exemplary embodiment of the invention.

Fig. 2 depicts the joint configuration taken along a line II-II in Fig. 1.

15 Fig. 3 depicts a first modification of the joint configuration according to the first exemplary embodiment of the invention.

Fig. 4 depicts a second modification of the joint configuration according to the first exemplary embodiment of the invention.

Fig. 5 depicts a joint configuration in another example.

20 Fig. 6 is an illustration for describing an angle when a reinforcing rebar extends in a direction oblique to the axial direction of secondary beams.

Fig. 7 is another illustration for describing the angle when the reinforcing rebar extends in a direction oblique to the axial direction of secondary beams.

25 Fig. 8 depicts a joint configuration according to a second exemplary embodiment of the invention.

Fig. 9 depicts a modification of the joint configuration according to the second exemplary embodiment of the invention.

Fig. 10 depicts a first modification of the joint configuration close to bottom flanges of secondary beams.

30 Fig. 11 depicts a second modification of the joint configuration close to bottom flanges of secondary beams.

DESCRIPTION OF EMBODIMENTS

[0010]

Preferred exemplary embodiments of the invention will be described in detail with reference to the accompanying drawings. In the present description and the drawings, components having substantially the same functional structures are denoted by the same symbols, and their redundant description will be omitted.

[0011]

First Exemplary Embodiment

Fig. 1 depicts a joint configuration according to a first exemplary embodiment of the invention. As illustrated, the joint configuration according to the first exemplary embodiment is formed between a primary beam 1 and secondary beams 2A and 2B. Each of the primary beam 1 and the secondary beams 2A and 2B is formed from an H-shaped steel beam. The primary beam 1 includes a web 11, a top flange 12, and a bottom flange 13, and the secondary beams 2A and 2B include webs 21A and 21B, top flanges 22A and 22B, and bottom flanges 23A and 23B, respectively. The primary beam 1 and the secondary beams 2A and 2B are not limited to H-shaped steel beams but any beam having an H-shaped cross section is usable: for example, a welded member having an H-shaped cross section is usable.

[0012]

In the present exemplary embodiment, gusset plates 31A and 31B and ribs 32A and 32B are disposed as joint members. The gusset plates 31A and 31B are welded to the web 11 and the top flange 12 of the primary beam 1, and the ribs 32A and 32B are welded to the web 11 of the primary beam 1 and to the gusset plates 31A and 31B, respectively. The web 21A of the secondary beam 2A is bolted to the gusset plate 31A, and the web 21B of the secondary beam 2B is bolted to the gusset plate 31B. The bottom flange 23A of the secondary beam 2A is joined to the rib 32A via a contact member 41A with metal touching, and the bottom flange 23B of the secondary beam 2B is joined to the rib 32B via a contact member 41B with metal touching. The contact members 41A and 41B are not limited to the illustrated example, and other various contact members described in, for example, Japanese Patent No. 6635175 and Japanese Patent No. 6631679 may be used.

[0013]

A concrete floor slab 5 is constructed over the primary beam 1 and the secondary beams 2A and 2B. In the illustrated example, the concrete floor slab 5 is a composite deck slab and includes concrete 51, reinforcing rebars 52, and a steel deck profile 53. As described later, the concrete floor slab 5 may include rebars other than the reinforcing rebars 52. Studs 6 are erected on the top flanges 12, 22A, and 22B of the primary beam 1 and the secondary beams 2A and 2B, respectively, so as to pass through the steel deck profile 53 and the studs 6 are fixed to the concrete 51. Specifically, in the illustrated example, the secondary beams 2A and 2B are joined to the concrete floor slab 5, and this allows the tensile forces acting on the top flanges 22A and 22B of the secondary beams 2A and 2B to be transmitted to the concrete floor slab 5. The top flanges 22A and 22B are not directly joined to the primary beam 1 and the gusset plates 31A and 31B.

[0014]

Fig. 2 depicts the joint configuration taken along a line II-II in Fig. 1. In Fig. 2, part of the concrete 51 and the steel deck profile 53 are illustrated transparent. In the present exemplary embodiment, the reinforcing rebars 52 embedded in the concrete 51 of the concrete floor slab 5 are disposed without extending over both the secondary beams 2A and 2B. Specifically, each of reinforcing rebars 52A disposed above the secondary beam 2A has an end portion 521A located above the primary beam 1 and does not extend above the secondary beam 2B. Similarly, each of reinforcing rebars 52B disposed above the secondary beam 2B has an end portion 521B located above the primary beam 1 and does not extend above the secondary beam 2A. The reinforcing rebars 52 herein mean reinforcing rebars disposed in a portion of the concrete floor slab 5 that is located close to the joint configuration between the primary beam 1 and the secondary beams 2A and 2B in order to reinforce the concrete floor slab 5 because a tensile force acts on this portion. Therefore, other rebars included in the concrete floor slab 5 such as welded wire meshes that are uniformly disposed over the entire area of the concrete floor slab 5 to prevent propagation of cracks may be disposed extending over both the secondary beams 2A and 2B. The welded wire meshes that are uniformly disposed over the entire area of the concrete floor slab 5 to prevent propagation of cracks can also contribute to an improvement in the rigidity of the joint portion. However, if only the

welded wire meshes are used, the resistance of the joint portion against the moment generated at the beam ends is insufficient, and it is therefore necessary to dispose the reinforcing rebars 52. Examples of the welded wire meshes uniformly disposed over the entire area of the concrete floor slab 5 to prevent propagation of cracks include, but not limited to, wire meshes having a wire diameter of 6 mm and a mesh size of 100 mm and deformed reinforcing rebars having a wire diameter of 10 mm and a mesh size of 200 mm. Examples of the reinforcing rebars include, but not limited to, reinforcing rebars having a nominal diameter of 10 to 16 mm and arranged not in a net pattern but in one direction with a pitch of 100 mm to 200 mm.

[0015]

Fig. 3 illustrates a first modification of the joint configuration according to the first exemplary embodiment of the invention. In the illustrated example, the reinforcing rebars 52 include reinforcing rebars 52C and 52D each having a portion extending in a direction oblique to the axial direction of the secondary beams 2A and 2B. Each of the reinforcing rebars 52C is disposed above the secondary beam 2A, extends in a direction oblique to the axial direction of the secondary beam 2A, and is turned back toward the secondary beam 2A at a turned-back portion 522A located above the primary beam 1. Each of the reinforcing rebars 52D is disposed above the secondary beam 2B, extends in a direction oblique to the axial direction of the secondary beam 2B, and is turned back toward the secondary beam 2B at a turned-back portion 522B located above the primary beam 1. In this manner, even in the example in Fig. 3, the reinforcing rebars 52 embedded in the concrete 51 of the concrete floor slab 5 are disposed without extending over both the secondary beams 2A and 2B.

[0016]

Fig. 4 illustrates a second modification of the joint configuration according to the first exemplary embodiment of the invention. In the illustrated example, the reinforcing rebars 52 include reinforcing rebars 52E and 52F each having a portion extending in a direction oblique to the axial direction of the secondary beams 2A and 2B. Each of the reinforcing rebars 52E is disposed above the secondary beam 2A, extends in a direction oblique to the axial direction of the secondary beam 2A, and has an end portion 521A located above the primary beam 1. Each of the reinforcing

rebars 52F is disposed above the secondary beam 2B, extends in a direction oblique to the axial direction of the secondary beam 2B, and has an end portion 521B located above the primary beam 1. In this manner, even in the example in Fig. 4, the reinforcing rebars 52 embedded in the concrete 51 of the concrete floor slab 5 are disposed without extending over both the secondary beams 2A and 2B. As in the illustrated example, the reinforcing rebars 52E and 52F may be turned back at turned-back portions 523A and 523B close to the secondary beam 2A and the secondary beam 2B, respectively, such that both the end portions of the reinforcing rebars 52E and 52F are located above the primary beam 1.

[0017]

In the present exemplary embodiment, the reinforcing rebars 52 embedded in the concrete 51 of the concrete floor slab 5 are disposed without extending over both the secondary beams 2A and 2B. Therefore, the arrangement of the reinforcing rebars 52 can be performed independently in any section on the secondary beam 2A or the secondary beam 2B with the primary beam 1 interposed therebetween. In this case, for example, while construction work of the steel deck profile is performed in one of the sections on the secondary beam 2A and the secondary beam 2B, reinforcing rebars can be arranged in the other of the sections thereof, so that the workability is improved. When the present exemplary embodiment is applied to, for example, a concrete floor slab using rebar truss decks, the reinforcing rebars may be stored below the top bars of the rebar trusses in advance, and then, after installation of a rebar truss deck, the reinforcing rebars may be arranged by being slid toward an adjacent span. Accordingly, even in a case where the reinforcing rebars are stacked on the top bars to make it difficult to ensure the required concrete cover thickness, a sufficient cover thickness can be obtained according to the present exemplary embodiment.

[0018]

Fig. 5 illustrates a joint configuration in another example. In the illustrated example, the reinforcing rebars 52 embedded in the concrete 51 of the concrete floor slab 5 include reinforcing rebars 52G and 52H respectively extending in directions oblique to the secondary beams 2A and 2B. In contrast to the examples illustrated in Figs. 1 to 4 described above, in the example illustrated in Fig. 5, the reinforcing rebars

52G and 52H are disposed extending over both the secondary beams 2A and 2B across the primary beam 1.

[0019]

When the reinforcing rebars extend in directions oblique to the axial direction of the secondary beams as in the examples in Figs. 3 to 5, of the tensile force acting on the reinforcing rebars, a component of the tensile force that is directed in the axial direction of the secondary beams 2 contributes to the restraint of the rotation of the end portions of the secondary beams 2. It is therefore desirable that the reinforcing rebars extend in directions not perpendicular to the axial direction of the secondary beams, e.g., in directions at an acute angle of 70 degrees or less to the axial direction of the secondary beams so that the above component of the tensile force is obtained.

[0020]

Figs. 6 and 7 are illustrations for further describing the angle when the reinforcing rebars extend in the directions oblique to the axial direction of the secondary beams, as in the examples in Figs. 3 to 5. In the illustrated examples, the concrete floor slab is supported for each rectangular region surrounded by primary beams 1 and at least one secondary beam 2. In this case, the concrete floor slab is largely distorted at the intersections of the diagonal lines of the rectangles, with the intersections of the beams (the intersections of the primary beams, the intersections of the primary beams and the secondary beams, and the intersection of a first-order secondary beam and a second-order secondary beams) serving as peaks and portions above the beams serving as ridges. In this concrete floor slab, it is desirable that the reinforcing rebars extend along the diagonal lines of the rectangles in order to prevent the deflection and cracking of the concrete.

[0021]

In the example illustrated in Fig. 6, which is a non-limiting example, four secondary beams 2 are arranged in parallel at 3-m intervals in a 15 m × 15 m region surrounded by primary beams 1. In each rectangular region surrounded by the primary beam(s) 1 and the secondary beam(s) 2, the length of sides along the secondary beams 2 is 15 m, and the length of sides perpendicular to the secondary beams 2 is 3 m. In this case, when the reinforcing rebars 52 (only one reinforcing rebar is illustrated) are disposed extending in the directions of the diagonal lines of

the rectangles, the angle θ_1 between the axial direction of the secondary beams 2 and the extending directions of the reinforcing rebars 52 is $\tan^{-1}(3/15) \approx 11.3$ degrees. In each of the examples in Figs. 6 and 7, a portion surrounded by a broken line corresponds to the joint configurations illustrated in Figs. 3 to 5.

5 [0022]

In the example illustrated in Fig. 7, which is also a non-limiting example, a single first-order secondary beam 2P is disposed bisecting a 15 m $\times$ 15 m region surrounded by primary beams 1, and four second-order secondary beams 2Q are arranged at 3-m intervals in each region surrounded by the primary beams 1 and the first-order secondary beam 2P. In each rectangular region surrounded by the primary beam(s) 1, the first-order secondary beam 2P, and the second-order secondary beam(s) 2Q, the length of sides along the first-order secondary beam 2P is 3 m, and the length of sides perpendicular to the first-order secondary beam 2P is 7.5 m. In this case, when the reinforcing rebars 52 (only one reinforcing rebar is illustrated) are each disposed extending in a direction of the diagonal line of the rectangle, the angle θ_2 between the axial direction of the first-order secondary beam 2P and the extending direction of each reinforcing rebar 52 is $\tan^{-1}(7.5/3) \approx 68.2$ degrees.

[0023]

From the viewpoint of the component of force and from the viewpoint that each reinforcing rebar passes through the intersection of the diagonal lines in each rectangular region supporting the concrete floor slab as described above, it is preferable that, when each reinforcing rebar extends in a direction oblique to the axial direction of each secondary beam, the angle between the axial direction of the secondary beam and the extending direction of each reinforcing rebar is in a range from 10 degrees to 70 degrees.

[0024]

Second Exemplary Embodiment

Fig. 6 illustrates a joint configuration according to a second exemplary embodiment of the invention. In the present exemplary embodiment, a tension member 7 is further disposed in a joint configuration that is similar to the joint configuration in the first exemplary embodiment formed between the primary beam 1 and the secondary beams 2A and 2B. One end portion of the tension member 7 is

engaged, using a nut 72A, with a plate 71A having a hole which is joined to the web 21A and the top flange 22A of the secondary beam 2A, and the other end portion is engaged, using a nut 72B, with a plate 71B having a hole which is joined to the web 21B and the top flange 22B of the secondary beam 2B. The tension member 7 is disposed passing through a through hole 111 formed in the web 11 of the primary beam 1, so that the tensile forces acting on the secondary beams 2A and 2B can be transmitted through the tension member 7 without being transmitted through the primary beam 1. The tension member 7 is illustrated as a steel rod having threaded ends, but the tension member 7 may be threaded along the entire length thereof. Alternatively, one end portion of the tension member 7 may be engaged with a plate having a hole using a flange welded in advance to the end portion, and only the other end portion may be threaded and engaged with a plate having a hole using a nut.

[0025]

In the present exemplary embodiment, since the tension member 7 is disposed, the tensile forces acting on the secondary beams 2A and 2B can be transmitted without being transmitted through the reinforcing rebars in the concrete floor slab 5. Therefore, even when the reinforcing rebars 52 embedded in the concrete 51 of the concrete floor slab 5 are disposed without extending over both the secondary beams 2A and 2B as described in the first exemplary embodiment, sufficient stress transmission performance can be easily obtained in the joint configuration. The tension member 7 with this configuration is applicable to the examples described with reference to Figs. 1 to 5. Moreover, for example, even when the reinforcing rebars extending in a direction parallel to the secondary beams are disposed extending across the primary beam, the tension member 7 disposed can transmit the tensile forces, and therefore the number of reinforcing rebars arranged can be reduced. In this case, a sufficient concrete cover thickness can be obtained, and the workability can be improved.

[0026]

In the description of the above example, the plates 71A and 71B with holes are joined to the top flanges 22A and 22B of the secondary beams 2A and 2B, respectively, and also to the webs 21A and 21B of the secondary beams 2A and 2B,

respectively. However, the plates 71A and 71B with holes may be joined only to the top flanges 22A and 22B or to the webs 21A and 21B.

[0027]

Fig. 7 illustrates a modification of the joint configuration according to the second exemplary embodiment of the invention. In the illustrated example, tension members 7A and 7B are separately disposed on opposite sides of the primary beam 1 and engaged with the primary beam 1 and the secondary beams 2A and 2B, respectively. Specifically, one end portion of the tension member 7A is engaged, using a nut 72A, with a plate 71A having a hole which is close to the secondary beam 2A, and the other end portion is engaged, using a nut 74A, with a plate 73A having a hole which is joined to the top flange 12 of the primary beam 1 and the gusset plate 31A. Similarly, one end portion of the tension member 7B is engaged, using a nut 72B, with a plate 71B with a hole on the secondary beam 2B side, and the other end portion is engaged, using a nut 74B, with a plate 73B having a hole which is joined to the top flange 12 of the primary beam 1 and the gusset plate 31B. The plates 73A and 73B having holes close to the primary beam 1 may be joined only to either the top flange 12 or the gusset plates 31A and 31B, respectively.

[0028]

In the joint configuration including the tension members 7A and 7B described above, these members are independent members disposed on the respective secondary beam 2A and 2B. Therefore, this joint configuration is also applicable to a case where only one secondary beam extending in a direction intersecting the primary beam 1 is disposed on one side of the primary beam 1. For example, in a case where the joint configuration joins the primary beam 1 and the secondary beam 2A together, the concrete floor slab 5 is constructed over the primary beam 1 and the secondary beam 2A, and the web of the secondary beam 2A is joined to the primary beam 1 via the gusset plate 31A. Then the tension member 7A may be disposed engaged with the primary beam 1 and with the top flange 22A or the web 21A of the secondary beam 2A. In this case, for example, using a nut 74, the tension member 7A may be engaged with the plate 73A having a hole close to the primary beam 1 or may be engaged in a through hole formed in the web 11 of the primary beam 1, such as the through hole 111 illustrated in Fig. 6.

[0029]

The example illustrated in Fig. 6 in which the tensile forces are transmitted between the secondary beams 2A and 2B that form a continuous beam extending on both sides of the primary beam 1 is not exhaustive. Even when the tensile forces are transmitted separately to the primary beam from the secondary beams 2A and 2B as in the example in Fig. 7, the tensile forces acting on the secondary beams 2A and 2B can be transmitted through the primary beam 1 without being transmitted through the reinforcing rebars in the concrete floor slab 5. Therefore, even when the reinforcing rebars 52 are disposed without extending over both the secondary beams 2A and 2B, sufficient stress transmission performance can be obtained in the joint configuration.

[0030]

In each of the examples of the second exemplary embodiment of the invention described above, prestress can be introduced to a negative bending region of the concrete 51 of the concrete floor slab 5 by introducing a tensile force to the tension member 7 (or the tension members 7A and 7B) after curing of the concrete 51 in the step of constructing the joint configuration. In this manner, cracking of the concrete 51 to be generated when a live load acts on the concrete floor slab 5 can be prevented.

[0031]

Modifications of Joint Configuration on Bottom Flange Side of Secondary Beams

Referring next to Figs. 8 and 9, modifications of the joint configuration on the bottom flange of the secondary beams in each of the examples described above will be described. As for the joint configuration other than the joint configuration on the bottom flange of the secondary beams, the joint configuration in the example in the second exemplary embodiment described above with reference to Fig. 6 is used. However, the joint configuration in this example is not exhaustive. The modifications of the joint configuration on the bottom flange of the secondary beams described below are applicable to all the examples described with reference to Figs. 1 to 7.

[0032]

Fig. 8 illustrates a first modification of the joint configuration on the bottom flange of the secondary beams. In the illustrated example, the bottom flange 23A of the secondary beam 2A is bolted to the rib 32A via splice plates 42A and 43A

attached to both sides of the bottom flange 23A and the rib 32A. Similarly, the bottom flange 23B of the secondary beam 2B is bolted to the rib 32B via splice plates 42B and 43B. As described above, not only with metal touching but also with bolts, the bottom flanges 23A and 23B of the secondary beams 2A and 2B may be joined to the joint members close to the primary beam 1 such as the ribs 32A and 32B. The bottom flanges 23A and 23B may be bolted to the joint members, so that compressive forces are transmitted from the bottom flanges 23A and 23B to the primary beam 1.

[0033]

Fig. 9 illustrates a second modification of the joint configuration on the bottom flange of the secondary beams. In the illustrated example, although the gusset plates 31A and 31B used as the joint members are disposed, no ribs are disposed, so that the bottom flanges 23A and 23B of the secondary beams 2A and 2B are not joined to the joint members close to the primary beam 1. Instead, reinforcing plates 33A and 33B are disposed in contact with side edge surfaces of the gusset plates 31A and 31B at positions lower than the centers of the webs 21A and 21B in height. The reinforcing plates 33A and 33B are bolted to the webs 21A and 21B, respectively, of the secondary beams 2A and 2B. The side edge surfaces of the gusset plates 31A and 31B are edge surfaces facing in the axial direction of the secondary beams 2A and 2B. With this configuration, the compressive forces acting on the bottom flanges 23A and 23B of the secondary beams 2A and 2B can be transmitted to the primary beam 1 with the metal touching between the gusset plates 31A and 31B and the reinforcing plates 33A and 33B.

[0034]

The joint configuration on the bottom flange of the secondary beams in the exemplary embodiment of the invention is not limited to those in the examples described above and may be any configuration. For example, in the example illustrated in Fig. 9, a configuration including no reinforcing plates 33A and 33B and simple pin joints added with the concrete floor slab 5 is usable. Even in this configuration, shearing forces in the secondary beams are transmitted via the pin joints, and also the tensile forces acting on the top flanges of the secondary beams are transmitted via the concrete floor slab or the tension member, so that the stress transmission performance of the joint configuration is improved.

[0035]

The preferred exemplary embodiments of the invention have been described in detail with reference to the accompanying drawings, but the invention is not limited to these exemplary embodiments. It is apparent that those skilled in the art to which
5 the invention pertains can conceive various changes and modifications within the scope of the technical idea described in the claims. It is understood that these changes and modifications, of course, belong to the technical scope of the invention.

EXPLANATION OF CODES

10 [0036]

1 primary beam, 11 web, 111 through hole, 12 top flange, 13 bottom flange, 2A, 2B secondary beam, 21A, 21B web, 22A, 22B top flange, 23A, 23B bottom flange, 31A, 31B gusset plate, 32A, 32B rib, 33A, 33B reinforcing plate, 41A, 41B contact member, 42A, 42B, 43A, 43B splice plate, 5 concrete floor slab, 51 concrete, 52, 52A,
15 52B, 52C, 52D, 52E, 52F, 52G, 52H reinforcing rebar, 53 steel deck profile, 6 stud, 7, 7A, 7B tension member, 71A, 71B, 73A, 73B plate with hole, 72A, 72B, 74A, 74B nut, 521A, 521B end portion, 522A, 522B, 523A, 523B turned-back portion

CLAIMS

[Claim 1]

A joint configuration comprising:

a primary beam having an H-shaped cross section;

5 first and second secondary beams each having an H-shaped cross section, each extending in a direction intersecting the primary beam, and having respective ends facing each other with the primary beam interposed therebetween; and

first and second joint members that join webs of the respective first and second secondary beams to the primary beam, wherein

10 a concrete floor slab is constructed over the primary beam and the first and second secondary beams,

top flanges of the respective first and second secondary beams are joined to the concrete floor slab and are not directly joined to the primary beam and the respective first and second joint members, and

15 a reinforcing rebar embedded in concrete of the concrete floor slab is disposed without extending over both the first and second secondary beams.

[Claim 2]

The joint configuration according to claim 1, wherein at least a part of the reinforcing rebar extends in a direction oblique to an axial direction of each of the first
20 and second secondary beams.

[Claim 3]

A joint configuration comprising:

a primary beam having an H-shaped cross section;

25 first and second secondary beams each having an H-shaped cross section, each extending in a direction intersecting the primary beam, and having respective ends facing each other with the primary beam interposed therebetween; and

first and second joint members that join webs of the respective first and second secondary beams to the primary beam, wherein

30 a concrete floor slab is constructed over the primary beam and the first and second secondary beams,

top flanges of the respective first and second secondary beams are joined to the concrete floor slab and are not directly joined to the primary beam and the respective first and second joint members, and

at least a part of a reinforcing rebar embedded in concrete of the concrete floor slab extends in a direction oblique to an axial direction of each of the first and second secondary beams.

[Claim 4]

The joint configuration according to any one of claims 1 to 3, wherein the reinforcing rebar has an end portion or a turned-back portion disposed above the primary beam.

[Claim 5]

The joint configuration according to any one of claims 1 to 4, wherein bottom flanges of the respective first and second secondary beams are joined to the primary beam or to the respective first and second joint members with metal touching or with bolts.

[Claim 6]

The joint configuration according to any one of claims 1 to 5, further comprising a tension member that is engaged with each of the top flanges or webs of the respective first and second secondary beams and passes through a through hole formed in a web of the primary beam.

[Claim 7]

A joint configuration comprising:

a primary beam having an H-shaped cross section;

a secondary beam having an H-shaped cross section and extending in a direction intersecting the primary beam; and

a joint member that joins a web of the secondary beam to the primary beam, wherein

a concrete floor slab is constructed over the primary beam and the secondary beam,

a top flange of the secondary beam is joined to the concrete floor slab and is not directly joined to the primary beam and the joint member, and

the joint configuration further comprises a tension member that is engaged with the top flange or web of the secondary beam and with a top flange or web of the primary beam.

[Claim 8]

5 A joint configuration comprising:

a primary beam having an H-shaped cross section;

first and second secondary beams each having an H-shaped cross section, each extending in a direction intersecting the primary beam, and having respective ends facing each other with the primary beam interposed therebetween; and

10 first and second joint members that join webs of the respective first and second secondary beams to the primary beam, wherein

a concrete floor slab is constructed over the primary beam and the first and second secondary beams,

15 top flanges of the respective first and second secondary beams are joined to the concrete floor slab and are not directly joined to the primary beam and the respective first and second joint members, and

the joint configuration further comprises a tension member that is engaged with the top flanges or webs of the respective first and second secondary beams and passes through a through hole formed in a web of the primary beam.

20 [Claim 9]

A method for constructing the joint configuration according to any one of claims 6 to 8,

the method comprising: introducing a tensile force to the tension member after concrete of the concrete floor slab is cured.

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