Title: STEEL-CONCRETE SANDWICH TYPE HYBRID BEAM AND HIGH STRENGTH HYBRID STRUCTURE SYSTEM USING THE SAME

Abstract: Disclosed herein are a steel-concrete sandwich-type hybrid beam and a high strength hybrid structure system using the same. A shape steel member is arranged in pairs on both sides of the beam and a concrete is filled between the pair of shape steel members, and thus a high rigidity and high damping performance of RC frame and a construction efficiency of steel framing can be achieved simultaneously. Therefore, a convenience of construction and a good improved structural rationality can be obtained, thus reducing the construction cost, as compared with the conventional RC and PC beams having the same rigidity. The steel-concrete sandwich-type hybrid beam is formed of a steel member and a concrete member. A pair of lateral shape steel member forming both side faces of the hybrid beam is provided. A filled concrete is placed and cured between the pair of lateral shape steel members. The lateral shape steel members are disposed in parallel at regular intervals along the longitudinal direction of the hybrid beam.
Steel-Concrete Sandwich Type Hybrid Beam and High Strength Hybrid Structure System Using the same

Technical Field

The present invention relates to a steel-concrete sandwich-type hybrid beam and a high strength hybrid structure system using the same. More specifically, the invention relates to a steel-concrete sandwich-type hybrid beam and a high strength hybrid structure system using the same, in which a shape steel member is arranged in pairs in both sides of the beam and a concrete is filled between the pair of shape steel members, and thus a high rigidity and high damping performance of RC frame and a construction efficiency of steel framing can be achieved simultaneously, thereby providing a convenience of construction and a good improved structural rationality and thus reducing the construction cost, as compared with the conventional RC and PC beams having the same rigidity.

Background Art

Recently, newly constructed building structures have been large-scaled and super-manhattanized in terms of their scale, and also complicated and diversified in termed of their functionality. However, in the construction of these structures, quite often the conventional steel framing or steel-concrete frame is not appropriate for the requirements of such building structures, in terms of their
material properties. In addition, these conventional framing may be unfavorable in terms of the construction conditions and economical efficiency. Thus, recently, a hybrid structure system has been proposed and attracted attentions. That is, departing from the conventional single-material structure system, two or more dissimilar materials are combined to form a structure, which takes advantage of each material and also compensates for disadvantages of other materials.

Currently, a typical hybrid structure system is exemplified by a SRC (steel reinforced concrete) structure, which is formed mainly of steel and concrete. In the construction of the SRC structure, a steel bar is arranged around a steel member and concrete is placed therein to thereby form a column or a beam, in which the three materials are integrated. In case of the above SRC structure, it is constructed such that relatively inexpensive concrete having a good compressive strength is commonly responsible for the stress (mainly compressive stress), which is imposed on the steel member in the conventional steel-concrete structure. Thus, due to a decrease in the volume of unit steel required, the construction cost can be effectively reduced.

However, in case of the above common-type SRC structure, concrete is placed around the central steel member in such a manner that the steel member is embedded in the concrete. Therefore, installations of a formwork for placing concrete and dismantling work
of the formwork are associated, similar to the conventional RC structure. Accordingly, due to the above formwork installation and dismantling, the construction labor and cost are increased and also the construction period is extended disadvantageously.

In addition, a factory building for precision high-tech products, such as a semiconductor or LCD production facility, corresponds to an anti-vibration building, which is particularly sensitive to vibration, as compared with other type of buildings. In case of these structures, in order to minimize the vibration, the beam member forming the structure body is required to have a high rigidity, rather than a ductile property. However, with the conventional RC structure, PC (precast concrete) structure, or SRC structure, in order to fabricate a beam member having a high rigidity as described above, the cross-section of the concrete must be significantly increased, and thus due to the increased concrete volume, the construction efficiency is not favorable, along with an increase in its own weight.

Therefore, there is an urgent need to provide a novel beam member, in which a rigidity-to-sectional area is higher as compared with the conventional structure types, and thus the structural efficiency is excellent, the formwork cost can be saved, and the construction period can be significantly shortened.
Disclosure of Invention

Accordingly, the present invention has been made in order to solve the above problems associated with the conventional hybrid structure system such as the conventional RC structure, PC structure, and SRC structure, and it is an object of the invention to provide an improved steel-concrete hybrid beam and a high-strength structure system using the same, in which a shape steel member is arranged in pairs at both sides of the beam so as to serve as a formwork so that installation and dismantling work of formwork are not required, thereby providing an improved convenience of construction and reducing the construction cost, and, also in terms of its structure, due to the combined effects of the steel members at both sides of the beam and the concerted placed in-between, enabling to considerably reduce the cross-sectional area, as compared with the conventional RC and PC beams having the same rigidity.

In order to accomplish the above object, according to one aspect of the invention, there is provided a steel-concrete sandwich-type hybrid beam formed of a steel member and a concrete member. The hybrid beam includes: a pair of lateral shape steel member for forming both side faces of the hybrid beam; and a filled concrete placed and cured between the pair of lateral shape steel members. The lateral shape steel members are disposed in parallel at regular intervals along the longitudinal direction of the hybrid beam.

That is, as shown in FIG. 1, compared with the construction of
the conventional beam members, in the steel-concrete sandwich-type hybrid beam 1 of the invention, basically the lateral shape steel member 10 is arranged in pairs at both sides of the beam, but not in the center thereof, to thereby form the outer faces of the beam. The concrete 20 is placed and cured between the pair of the lateral shape steel members 10.

In addition, the steel-concrete sandwich-type hybrid beam 1 has the above-described construction. Thus, in terms of its structure, the lateral shape steel member 10, which is a steel member disposed symmetrically at both side of the beam, is responsible for a significant portion of stress (especially, tension stress) exerted on the beam. Simultaneously, the filled concrete 20 filled between the lateral shape steel members 10 is responsible for a greater part of the working stress. Therefore, the considerable portion of steel materials can be replaced with inexpensive concrete, thereby providing a beam member having a good structural performance, with a reduced fabrication cost. In particular, according to the present invention, due to the filled concrete 20 disposed between the lateral shape steel members 10, the invention can take advantage of the high rigidity and high damping performance of an RC frame. Thus, even in the case where external vibration energy is exerted thereon, for example, by a strong wind or an earthquake, the displacement thereof can be maximized. Accordingly, the steel-concrete sandwich-type hybrid beam of the invention is suitable for an anti-vibration
building structure (semiconductor, LCD factory building, etc.), which is particularly sensitive to vibration.

Furthermore, in terms of the construction efficiency and economical efficiency, as described above, the lateral shape steel members 10 are arranged at both sides of the beam and the filled concrete 20 is placed in-between. The pair of lateral shape steel members serves as a formwork for placing concrete during construction. Thus, a formwork installation and dismantling work is not required, dissimilar to the convention RC beam or SRC beam, thereby significantly reducing the construction period and cost.

**Brief Description of Drawings**

Further objects and advantages of the invention can be more fully understood from the following detailed description taken in conjunction with the accompanying drawings, in which:

FIG. 1 is a cross-sectional view of a steel-concrete sandwich-type hybrid beam according to an embodiment of the invention;

FIGS. 2 to 11 are cross-section views of a steel-concrete sandwich-type hybrid beam according to another embodiments of the invention;

FIGS. 12 and 13 are plan views of a high-strength hybrid structure system according to an embodiment of the invention; and

FIGS. 14 to 18 shows hybrid structure systems according to the invention where the steel-concrete sandwich-type hybrid beam is
applied to a conventional column structure.

Best Mode for Carrying Out the Invention

The preferred embodiments of the present invention will be hereafter described in detail with reference to the accompanying drawings.

FIG. 1 is a cross-sectional view of a steel-concrete sandwich-type hybrid beam according to an embodiment of the invention. As illustrated in FIG. 1, this embodiment of the invention, as a whole, is constituted of a hybrid beam formed of a steel member and a concrete member. The hybrid beam is composed of a pair of lateral shape steel members 10 for forming both side faces of the beam and a filled concrete 20 placed and cured between the pair of lateral shape steel members 10. The lateral shape steel members 10 are disposed in parallel at regular intervals along the longitudinal direction of the hybrid beam.

In the constitution of the invention as described above, the lateral shape steel member 10 indicates a structural member fabricated in the form of elongated member so as to have a certain constant cross-section using a common structural steel material, which is mainly used in a construction structure. As described above, the lateral shape steel member 10 may employ various shaped members, such as a common-type H-steel beam, a C-shape channel, Z-steel beam, or the like, depending on specific designs. In the illustrated
embodiment, an H-steel beam is employed, which can be used most commonly as a lateral shape steel member.

In addition, the filled concrete 20 corresponds to a general concrete, which is placed between the pair of lateral shape steel members 10 to thereby fill the inside of the hybrid beam. According to the invention, the filled concrete may be placed separately, but most commonly is placed simultaneously together with a slab concrete, which is to be formed above the hybrid beam. Furthermore, a lower bottom-support plate 30 is provided in order to tightly close the lower side of the hybrid beam to thereby prevent the placed concrete from being leaked downwards when placing the filled concrete 20. In the embodiment illustrated in FIG. 1, the lower bottom-support plate 30 employs a steel plate, which is installed over a lower flange 12 of the lateral shape steel member 10.

On the other hand, in case of the hybrid beam according to the present invention, dissimilar steel frame and concrete are combined with each other to construct a single member. Preferably, thus, a separate sheer connector 50 is connected to the inner side face of the lateral shape steel member 10, i.e., the side face of the web 13 such that the steel member and the concrete member can be integrally behaved. In the embodiment illustrated in FIG. 1, the sheer connector 50 employs a stud bolt, but a shape steel stud or a steel rod stud can be fabricated and utilized by cutting a shaped steel or a steel rod at certain lengths.
FIGS. 2 and 3 are cross-sectional views of a steel-concrete sandwich-type hybrid beam according to another embodiments of the invention. In case of the embodiments illustrated in FIGS. 2 and 3, in stead of using a H-steel beam as in FIG. 1, the lateral shape steel member 10 employs a C-channel steel beam having a 'C'-shape as a whole along with the horizontal upper and lower flanges 11 and 12 and the vertical web 13, as shown in FIG. 2. Alternatively, as illustrated in FIG. 3, the horizontal upper and lower flanges 11 and 12 and the vertical web 13 are included, but the upper and lower flanges 11 and 12 are protruded in opposite directions to each other to thereby form a Z-steel beam.

In the embodiment illustrated in FIG. 4, a separate lower bottom-support plate 30 described above is not installed, and instead the lower flange 12 of the lateral shape steel member 10 is modified such that the filled concrete 20 can not be leaked downwards. According to this embodiment, in the lateral shape steel member 10, the lower flange 12 thereof is made so as to have a length longer than that of the upper flange 11 and such that the ends of the lower flanges 12 are abutted against each other. Thus, the lower side of the hybrid beam is closed by means of the lower flanges 12. In this embodiment, if an existing H-steel beam is intended to be used as the lateral shape steel member, a separate special order is required and thus the manufacturing cost is disadvantageously increased. Therefore, a steel plate such as a plate girder may be welded to
thereby form a lateral steel shape member 10 suitable to this embodiment of the invention. On the other hand, FIG. 4 illustrates a lateral shape steel member 10 having an H-shape cross-section. However, in case of the lateral shape steel member shown in FIGS. 2 and 3, the lower flange 12 thereof may be extended to thereby form a similar construction to that of FIG. 4.

In addition, as a modification for the lower bottom-support plate 30, FIG. 5 illustrates a precast concrete panel 12', dissimilar to the one illustrated in FIG. 4. That is, in this embodiment, the length of the lower flange 12 remains unchanged and thus a existing shape steel beam can be employed, dissimilar to the previous embodiment (FIG. 4) where the lower flange 12 of the lateral shape steel member 10 is extended. This embodiment is configured such that a precast concrete panel 12' is formed in combination with the lower flange 12 in such a manner that the precast concrete 12' acts as a lower formwork for the filled concrete 20.

On the other hand, as the lower bottom-support plate 30, a steel plate shown in FIGS. 1 to 3 may be employed, and also a variety of members such as a deck plate or a wooden soffit may be used, when needed. In case of the embodiment illustrated in FIG. 6, the lower bottom-support plate 30 employs a deck plate. The deck plate may employ a bent deck plate, or a deck plate where a trust wire is combined therewith may be used, as shown in FIG. 6.

FIG. 7 is a cross-sectional view of a steel-concrete sandwich-
type hybrid beam according to another embodiment of the invention. This embodiment is further provided with a reinforcement steel bar 25 arranged inside the filled concrete 20 in order to reinforce the structural rigidity therefor. At this time, the reinforcement steel bar 25 is comprised of a main bar 25-1 arranged along the longitudinal direction of the beam and a hoop bar 25-1 surrounding the main bar 25-1, similar to a common-type arrangement of bar. In addition, FIG. 8 is a cross-sectional view of a steel-concrete sandwich-type hybrid beam according to yet another embodiment of the invention. The embodiment of FIG. 8 is configured such that a pre-stress can be introduced at the lower side of the beam, to thereby further strengthen the structural performance thereof. That is, as illustrated in FIG. 8, this embodiment is provided with one or more through-hole 26 formed at the lower side of the filled concrete 20 along the longitudinal direction of the beam. Then, with a strand (not shown) passed through the through-hole 26, both ends are stressed so that a pre-stress can be introduced through a post-tension process.

On the other hand, in case of the steel-concrete hybrid beam, as can be understood from the structural constitution thereof, both side faces thereof is exposed with a steel skeleton member so that a flame retardancy may become a problem. Thus, FIG. 9 illustrates an embodiment where a fire-proof coating 18 is provided in the outer face of the lateral shape steel member 10.
As previously described, in the steel-concrete hybrid beam according to the present invention, the adhesive force between the steel skeleton of main constitution and the concrete is of great importance in terms of the structural integration thereof. Thus, in order for the lateral shape steel member 10 and the filled concrete 20 to be integrally behaved, it is preferable that a sheer connector 50 is further provided in the inner face of the lateral shape steel member 10. This sheer connector 50 may employ various kinds of sheer connectors including a common stud bolt, selectively depending on the circumstances. That is, as shown in FIG. 10, a '∟'-channel shape steel can be cut into a certain length to thereby form a shape steel stud, which can be attached as shown in the left side of FIG. 10. Alternatively, a steel bar stud, which is formed by bending a steel bar into a 'U' shape, may be welded to the lateral shape steel member 10.

FIG. 11a illustrates a case where a bar stud is employed as the sheer connector 50. A rod material such as a steel bar or a steel rod having a length longer than the width of the hybrid beam is used as a bar stud 50, which is hung over between the lateral shape steel members 10. In case of this type of bar stud 50, since it is embedded in the filled concrete 20, the bonding force between the lateral shape steel member 10 and the filled concrete 20 can be enhanced. Simultaneously, since it restrains both lateral shape steel members 10 to each other to thereby improve the structural
strength thereof. At this time, in the installation of the bar stud 50, a thread-type bar stud having a thread formed in the entire body thereof may be used. Alternatively, the end portion of the rod material such as a steel bar is formed with a thread, and a nut is fastened to the thread to thereby fix the bar stud.

In addition, FIG. 11b illustrates another embodiment where a sheer connector is formed in the lateral shape steel member 10. In this embodiment, a vertical stiffener 55 is installed in the inner side face of the web of the lateral shape steel member 10. As well known in the art, the vertical stiffener 55 corresponds to a reinforcement plate, which is installed at regular intervals in the web in order to prevent a localized buckling in a common steel-skeleton beam or a plate girder. In this embodiment, the vertical stiffener 55 installed as illustrated functions to strength integration with the filled concrete 20 and also reinforce the lateral shape steel member 10 as in a common-type stiffener, thereby providing an effect of strengthening the structural performance of the whole beam member.

Hereafter, a high strength hybrid structure system using the steel-concrete sandwich hybrid beam according to the invention will be described, referring to the accompanying drawings. FIGS. 12 and 13 are plan views of a hybrid structure system according to the invention. Specifically, FIG. 12 illustrates an embodiment of the invention where the steel-concrete sandwich hybrid beam 1 is arranged
in an one-way fashion, and FIG. 13 illustrates another embodiment of the invention where the steel-concrete sandwich hybrid beam 1 is arrange in a two-way pattern. On the other hand, unexplained reference numeral 200 denotes a common-type beam member.

As illustrated in FIGS. 12 and 13, the high strength hybrid structure system of the invention generally includes a plurality of columns 100 installed vertically on top of a base or a slab, and a plurality of steel-concrete sandwich-type hybrid beams 1 as a girder member horizontally installed over between the columns 100. The steel-concrete sandwich-type hybrid beam 1 is comprised of a pair of lateral shape steel members 10 forming both side faces of the beam and a filled concrete 20 placed and cured between the pair of lateral shape steel members 10. The lateral shape steel members 10 are disposed in parallel at regular intervals along the longitudinal direction of the hybrid beam.

The steel-concrete sandwich-type hybrid beam of the invention having the previously described construction can be applied to and combined with various conventional column systems, including a general column process such as an RC (or PC), a steel-skeleton, or a SRC process, and a CFT column process, which has been used recently and widely. Thus, a variety of structure-frame modes can be formed. A specific application for each process will be hereinafter described in detail.

In addition, in the case where the steel-concrete sandwich-
type hybrid beam is applied to a steel-skeleton structure or an SRC structure, when in the initial erection process, a steel skeleton member alone can be installed to form a frame. Thus, a tower crane can be used to carry out a lifting-up construction. In addition, since the entire frame can be finished before placing concrete for an inside filled concrete, the installation efficiency can be improved to thereby enable to shorten the construction period therefor.

Furthermore, in the high-strength hybrid structure system using the steel-concrete sandwich-type hybrid beam of the invention, the steel member, i.e., the lateral shape steel member is mostly responsible for the stress and strength in terms of the structure thereof. Due to the combination effect with the filled concrete filled and cured inside the steel members, the rigidity of the entire hybrid beam is increased and the damping performance thereof is improved, thereby enabling to effectively deal with problems, which may occur when in use.

The above high-strength hybrid structure system using the steel-concrete sandwich-type hybrid beam of the invention can be combined with various conventional types of columns. Hereafter, specific embodiments using the steel-concrete sandwich-type hybrid beam of the invention will be presented and explained for each respective column type, referring the accompanying drawings.

(1) Details on connection with CFT (Concrete Filled Tube) column.
FIG. 14 is a sectional view showing details on the connection of a steel-concrete sandwich-type hybrid beam of the invention to a CFT column. As illustrated in FIG. 14, the steel-concrete sandwich-type hybrid beam 1 of the invention is combined with a CFT-type column 110. Here, a diaphragm 112 is installed at a certain height of the CFT-type column 110, and the hybrid beam 1 of the invention is connected to the side end portion of the diaphragm 112. At this time, it is preferable that the hybrid beam 1 and the diaphragm 112 are welded to each other.

(2) Details on connection with RC (or PC) column

FIG. 15 is a sectional view showing details on the connection of a steel-concrete sandwich-type hybrid beam of the invention to a RC (reinforced concrete) column. As shown in FIG. 15, the steel-concrete sandwich-type hybrid beam 1 is combined with a conventional RC column 120 in such a way that the lateral shape steel member 10 of the hybrid beam 1 passes horizontally through the RC column 120. At this time, when constructing the above structure, the lateral shape steel member 10 is installed horizontally above the already-constructed RC column 120, and, at this state, the slab concrete and a filled concrete 20 can be placed. Alternatively, a column formwork is installed on the lower slab, and above the column formwork is installed the lateral shape steel member 10. At this state, the slab concrete, the filled concrete 20 and the column concrete 121 can be placed simultaneously.
(3) Details on connection with SRC column

FIG. 16 is a sectional view showing details on the connection of a steel-concrete sandwich-type hybrid beam of the invention to a SRC (steel reinforced concrete) column in a one-way fashion. As shown in FIG. 16, the hybrid beam 1 is connected to the SRC column, which is formed by placing a steel-concrete inside a column steel 133. That is, the column steel 133 is arranged in pairs and embedded in a concrete 132 and then the lateral shape steel member 10 of the steel-concrete sandwich-type hybrid beam 1 is connected to the column steels 133 respectively. At this time, the lateral shape steel member 10 is constructed in such a way as to be connected in a strong axis direction of the column steel 133.

FIG. 17 is a sectional view showing details on the connection of a steel-concrete sandwich-type hybrid beam 1 of the invention to a SRC column 130 in a two-way pattern. In this embodiment, similar to FIG. 16, an H-beam column steel 133 is arranged in pairs, and at the same time a flat steel plate is connected horizontally between the pair of the H-beam column steel 133 to thereby form a diaphragm 135. Then, the steel-concrete sandwich-type hybrid beam 1 is connected to the side end portion of the diaphragm 135 using a welding process or the like.

(4) Details on connection with steel column

FIGS. 18 and 19 illustrate embodiments of the invention where the steel-concrete sandwich-type hybrid beam of the invention is
applied to a steel column. Specifically, FIG. 18 is a sectional view showing an embodiment where the hybrid beam 1 of the invention is connected to the steel column 140 in a one-way fashion. FIG. 19 is a sectional view showing an embodiment where the hybrid beam 1 of the invention is connected to the steel column 140 in a two-way pattern. As illustrated in FIGS. 18 and 19, the steel-concrete sandwich-type hybrid beam 1 of the invention is connected to the steel column 140 such that the column steel 140 makes one pair with the lateral shape steel member 10 of the hybrid beam 1. It is preferable that the end portion of the lateral shape steel member 10 is bonded to each of the column steel 140.

On the other hand, as shown in FIGS. 17 and 18, in the case where the column steel 140 is formed in pairs (in two pieces), the web of the column steel 140 is made longer than the flange thereof, as compared with a common-type column steel. Thus, the slenderness ratio of column becomes larger so that a buckling or the like is likely to occur, thus needing an appropriate countermeasure. In FIGS. 18 and 19, unexplained reference numeral 145 denotes a side plate installed in order to solve the above problem. The side plate 145 is installed in such a way as to connect the pair of column steels 140 to each other, thereby reducing the length of buckling and increasing the rigidity thereof.

**Industrial Applicability**
As described above, the present invention has been made in order to solve the above problems with the conventional hybrid structure system such as the conventional RC structure, PC structure, and SRC structure. According to the improved steel-concrete hybrid beam and a high-strength structure system using the same, a shape steel member is arranged in pairs at both sides of the beam so as to serve as a formwork so that installation and dismantling work of formwork are not required. Therefore, an improved convenience of construction can be achieved and the construction cost can be reduced.

Also, in terms of its structure, due to the combined effects of the steel members at both sides of the beam and the concerted placed in-between, the cross-sectional area thereof can be considerably reduced, as compared with the conventional RC and PC beams having the same rigidity.

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

1. A steel-concrete sandwich-type hybrid beam formed of a steel member and a concrete member, comprising: a pair of lateral shape steel members for forming both side faces of the hybrid beam in such a way as to be disposed in parallel at regular intervals along the longitudinal direction of the hybrid beam; and a filled concrete placed and cured between the pair of lateral shape steel members.

2. The hybrid beam according to claim 1, wherein the lateral shape steel member includes an H-steel beam consisting of a horizontal upper and lower flange and a vertical web.

3. The hybrid beam according to claim 1, wherein the lateral shape steel member includes a C-channel beam having as a whole a 'C'-shape including a horizontal upper and lower flange and a vertical web.

4. The hybrid beam according to claim 1, wherein the lateral shape steel member includes a Z-steel beam including a horizontal upper and lower flange and a vertical web wherein the upper flange and the lower flange are protruded in opposite direction to each other.
5. The hybrid beam according to any one of claims 2 to 4, wherein a lower bottom-support plate is installed over the lower flange in such a way as to be hung over between the both lower flanges.

6. The hybrid beam according to claim 5, wherein the lower bottom-support plate includes any one of a steel plate, a deck plate and a wooden soffit.

7. The hybrid beam according to any one of claims 2 to 4, wherein the length of the lower flange is made to be longer than that of the upper flange, and simultaneously the pair of lateral shape steel members are installed such that the ends of the lower flanges thereof are abutted against each other.

8. The hybrid beam according to any one of claims 1 to 4, wherein a sheer connector is installed in the inner side face of the lateral shape steel member to thereby enhance the adhesive force with the filled concrete.

9. The hybrid beam according to claim 8, wherein the sheer connector includes any one of a stud bolt, a shape steel stud and a steel rod stud.
10. The hybrid beam according to any one of claims 1 to 4, wherein one or more bar stud are installed between the pair of lateral shape steel members in such a way as to connect the pair of lateral shape steel members in a horizontal direction.

11. The hybrid beam according to claim 10, wherein the bar stud is provided with a thread formed at least at the end portion of the entire length and a bolt is fastened to the thread from the outer face of the lateral shape steel member, thereby fixing the bar stud.

12. The hybrid beam according to any one of claims 1 to 4, wherein a vertical stiffener is further installed in the inner face of the web of the lateral shape steel member at regular intervals.

13. The hybrid beam according to any one of claims 1 to 4, wherein a reinforcement steel bar is further arranged inside the filled concrete.

14. The hybrid beam according to claim 13, wherein the reinforcement steel bar includes a plurality of main bars installed in the longitudinal direction of the beam and a hoop bar surrounding the main bar.
15. The hybrid beam according to any one of claims 1 to 4, wherein the filled concrete is provided with a plurality through-holes at the lower inside thereof such that a post-tension strand can be passed through the through-hole.

16. The hybrid beam according to any one of claims 2 to 4, wherein a precast panel formed of concrete is further attached to a lower flange of the lateral shape steel member.

17. The hybrid beam according to any one of claims 1 to 4, wherein the lateral shape steel member is further provided with a flame-retardancy coating formed in the outer face thereof.

18. A high strength hybrid structure system comprising a plurality of columns installed vertically on top of a base or a slab, and a plurality of steel-concrete sandwich-type hybrid beams as a girder member horizontally installed over between the columns, wherein the steel-concrete sandwich-type hybrid beam includes a pair of lateral shape steel member for forming both side faces of the beam in such a way as to be disposed in parallel at regular intervals along the longitudinal direction of the hybrid beam and a filled concrete placed and cured between the pair of lateral shape steel members.
19. The hybrid structure system according to claim 18, wherein the column includes a conventional CFT column having a diaphragm installed therein, and the steel-concrete hybrid beam is connected to the side end portion of the diaphragm.

20. The hybrid structure system according to claim 18, wherein the column includes a conventional RC column, and the steel-concrete sandwich-type hybrid beam is combined with the column in such a way that the lateral shape steel member passes horizontally through the RC column.

21. The hybrid structure system according to claim 18, wherein the column includes an SRC column where a pair of H-beam column steels is embedded therein in parallel spaced apart from each other, and the steel-concrete sandwich-type hybrid beam is combined with the column in such a way that the lateral shape steel member is bonded to the side face of a flange of the column steel.

22. The hybrid structure system according to claim 21, wherein a flat steel plate is installed horizontally between the pair of the H-beam column steels to thereby form a diaphragm, and the steel-concrete sandwich-type hybrid beam, which is installed in a weak axis direction of the column steel, is bonded to the side end portion of the diaphragm.
[Fig. 7]

[Fig. 8]
Intermediate portion of column
A. CLASSIFICATION OF SUBJECT MATTER

IPC7 E04C 3/293

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC7 E04C, E04B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

KR, JP IPC as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

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Further documents are listed in the continuation of Box C. See patent family annex.

Date of the actual completion of the international search 13 JUNE 2005 (13.06.2005)

Date of mailing of the international search report 14 JUNE 2005 (14.06.2005)

Name and mailing address of the ISA/KR

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