

SPECIFICATION

VISCOELASTIC BRACE

5 BACKGROUND OF THE INVENTION

TECHNICAL FIELD

The present invention relates to a viscoelastic
brace capable of providing a damping effect in a building
or other structures when an external force is exerted by
10 an earthquake or wind.

DESCRIPTION OF THE PRIOR ART

Conventional vibration control devices are disclosed
as follows. As shown in Figs. 7(a) and 7(b), there is
15 provided a vibration control device 102 in which steel
plates 103 and viscoelastic bodies 104 are laminated and
made to adhere onto an end portion of a brace 101. This
vibration control device 102 is shown on pages 629 to 630
of the summary of the lecture meeting of Architectural
20 Institute of Japan which was held in Kyushu on October in
1989. As shown in Figs. 8(a), 8(b) and 8(c), there is
provided a vibration control device 115 in which a
viscoelastic layer 113 is interposed between an inner
circumferential surface of an outer brace member 111 made
25 of steel and an outer circumferential surface of an inner
brace member 112 made of steel, wherein this structure is
clearly shown in Fig. 8(b). As disclosed in Japanese
Examined Patent Publication No. 2583801, there is shown a
vibration control device 116 for controlling vibration of
30 a building in which a hardening agent 114 of cement is
fixed in a pipe body of an outer brace member 111 made of
steel, and a viscoelastic material layer 113 is
interposed between an inner circumferential surface of
this hardening agent 114 of cement and an outer
35 circumferential surface of an inner brace member 112 made
of steel, wherein this structure is clearly shown in Fig.
8(c).

In a building such as a high-rise building in which the height of the building is larger than the width, there is a possibility that the structure is greatly influenced by vibration caused by an earthquake and wind.

5 In order to cope with the above vibration, a conventional vibration control device, which is attached to an end portion of the brace, and also a conventional vibration control device, in which the viscoelastic layer is interposed between the inner circumferential surface of
10 the outer brace member made of steel and the outer circumferential surface of the inner brace member made of steel, are disadvantageous as follows. In the above vibration control device, a portion in which vibration energy is absorbed is limited to the end portion, or only
15 one viscoelastic layer can be inserted. Therefore, a total area of viscoelastic body which can be interposed in the vibration control device is limited, and it is impossible to increase an energy absorbing capacity of the brace. When the structure of the prior art shown in
20 Figs. 7(a) and 7(b) is extended to the overall length of the brace so that the total area of the viscoelastic body is increased, there is a possibility that flat steel plates laminated between the viscoelastic bodies are buckled by a compression force given to the brace, and
25 further there is a possibility that a viscoelastic layer of the outermost layer and a flat plate are peeled off outside.

In order to solve the above problems, as disclosed in Japanese Unexamined Patent Publication No. 9-133169,
30 there has been proposed a structure in which a viscoelastic body is made to adhere between an outer and an inner cylinder. However, in order to realize the above structure, it is necessary to pour liquid viscoelastic material into between the outer and the
35 inner cylinder. Therefore, the following problems may be encountered in the above structure. It is impossible to make a solid body such as a viscoelastic sheet adhere

between the outer and the inner cylinder. Further, only one layer of the viscoelastic body can be composed in the above structure, that is, it is impossible to enhance a vibration energy absorbing capacity by composing a plurality of viscoelastic layers. As disclosed in Japanese Unexamined Patent Publication No. 1-187271, there has been proposed a structure in which a viscoelastic body is interposed between pipe bodies, the sections of which are closed, and the viscoelastic body is made to adhere between the double pipe bodies. Due to the above structure, resistance with respect to a force given to an external direction of the surface can be enhanced. However, in the above structure, the viscoelastic body is made to adhere onto a surface of the inner pipe and interposed between the inner pipe and the outer pipe so that the viscoelastic body can be made to adhere. Therefore, it is impossible to enhance the vibration energy absorbing capacity by providing a plurality of viscoelastic layers. In the above structure, the viscoelastic body is interposed between the outer pipe and the inner pipe, which are separated from each other, however, the separate outer pipes are contacted with each other. Therefore, it is impossible to make the viscoelastic body sufficiently adhere to the outer and the inner pipe. In order to make the outer pipe sufficiently adhere to the viscoelastic body, it is necessary to arrange separate outer pipes at regular intervals. For the above reasons, it is impossible to make the outer and the inner pipe sufficiently adhere to the viscoelastic body by the prior art.

SUMMARY OF THE INVENTION

The present invention is accomplished to solve the above problems and is composed as follows.

(1) The present invention provides a viscoelastic brace comprising: a first core member and a second core member made of shape steel, an angle steel pipe or round

steel pipe, the first core member and the second core member being arranged along a line to define an extension or contraction space therebetween; a single layer of a set of steel channels or semi-circular steel plates, which are opposed to each other surrounding the first core member, provided being laminated on the side surfaces of the first core member; and a single layer of viscoelastic sheet provided being laminated on the side surfaces of the first core member, wherein the steel channels or semi-circular steel plates are secured at an end of the second core member, and the first and the second core member are viscoelastically connected with each other through the steel channels or the semi-circular steel plates and the viscoelastic sheets.

(2) The present invention provides a viscoelastic brace according to item (1), wherein a plurality of sets of steel channels or semi-circular steel plates which are opposed to each other and a plurality of viscoelastic sheets are arranged and laminated and made to adhere to each other, and end portions of the steel channels or semi-circular steel plates are alternately made to adhere to a portion in the proximity of the end portion of the second or the first core member.

(3) The present invention provides a viscoelastic brace according to item (1) or (2), wherein a cover is made to adhere to the outermost steel channels or semi-circular steel plates, by which a side of one of the outermost steel channels or semi-circular steel plates which are opposed to each other and a side of the other of the outermost steel channels or semi-circular steel plates which are opposed to each other are connected with each other.

(4) The present invention provides a viscoelastic brace according to one of items (1) to (3), wherein the steel channels or the semi-circular steel plates which are opposed to each other are arranged at predetermined intervals.

(5) The present invention provides a viscoelastic brace according to one of items (1) to (4), wherein the steel channels composing the first and the second core member are one of H sections, I sections, assembled members of H sections and assembled members of I sections, a single layer of one set of steel channels which are opposed to each other and also a single layer of viscoelastic sheet are laminated and made to adhere onto a side of the web of the first core member, and end portions of the steel channels which are opposed to each other being arranged on the side of the web are made to adhere to the second core member.

(6) The present invention provides a viscoelastic brace according to item (5), wherein a plurality of sets of steel channels and viscoelastic sheets are opposed to each other being arranged on the sides of the web, a plurality of sets of steel channels and viscoelastic sheets are alternately laminated and made to adhere to each other, and the end portions of the steel channels are alternately made to adhere to a portion in the proximity of the end of the second core member or the first core member.

(7) The present invention provides a viscoelastic brace comprising: a first core member and a second core member made of H sections, I sections, assembled members of H sections and assembled members of I sections, the first core member and the second core member being arranged along a line to define an extension or contraction space therebetween; and a single layer of a set of steel channels and viscoelastic sheets, which are opposed to each other, provided being laminated on the side surfaces of the web of the first core member, wherein end portions of the steel channels are made to adhere to the second core member, and the first and the second core member are viscoelastically connected with each other through the steel channels and the viscoelastic sheets.

(8) The present invention provides a viscoelastic brace according to item (7), wherein a plurality of sets of steel channels and viscoelastic sheets are opposed to each other being arranged on the sides of the web, a
5 plurality of sets of steel channels and viscoelastic sheets are alternately laminated and made to adhere to each other, and the end portions of the steel channels are alternately made to adhere to a portion in the proximity of the end of the second core member or the
10 first core member.

(9) The present invention provides a viscoelastic brace according to one of items (1) to (8), wherein at least one set of the plurality of sets of steel grooves or semi-circular steel plates which are opposed to each
15 other and viscoelastic sheets provided thereon are arranged only on one side.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1(a), (b) and (c) are a view showing an example to which a viscoelastic brace of the present invention is
20 applied, wherein Fig. 1(a) is a view showing an example, Fig. 1(b) is a view showing another example and Fig. 1(c) is a view showing still another example.

Fig. 2(a), (b), (c) and (d) are a view showing Embodiment 1 of a viscoelastic brace of the present
25 invention, wherein Fig. 2(a) is a longitudinally cross-sectional view, Fig. 2(b) is a view showing an example of a cross-sectional view taken on line A - A in Fig. 2(a) in the case where the first core member 3 and the second core member 4 are made of H sections, Fig. 2(c) is a view
30 showing another example of a cross-sectional view taken on line A - A in Fig. 2(a) in the case where the first core member 3 and the second core member 4 are made of angle steel pipes, and Fig. 2(d) is a view showing still
35 another example of a cross-sectional view taken on line A - A in Fig. 2(a) in the case where the first core member 3 and the second core member 4 are made of round pipes.

Fig. 3(a), (b), (c) and (d) are a view showing Embodiment 2 of a viscoelastic brace of the present invention, wherein Fig. 3(a) is a longitudinally cross-sectional view, Fig. 3(b) is a view showing an example of a cross-sectional view taken on line B - B in Fig. 3(a) in the case where the first core member 3 and the second core member 4 are made of H sections, Fig. 3(c) is a view showing another example of a cross-sectional view taken on line B - B in Fig. 3(a) in the case where the first core member 3 and the second core member 4 are made of angle steel pipes, and Fig. 3(d) is a view showing still another example of a cross-sectional view taken on line A - A in Fig. 3(a) in the case where the first core member 3 and the second core member 4 are made of round pipes.

Fig. 4(a) and (b) are a view showing Embodiment 3 of a viscoelastic brace of the present invention, wherein Fig. 4(a) is a longitudinally cross-sectional view and Fig. 4(b) is a view showing an example of a cross-sectional view taken on line D - D in Fig. 4(a) in the case where the first core member 3 and the second core member 4 are made of H sections.

Fig. 5(a) is a cross-sectional view taken on line C - C in Fig. 4(a), and Fig. 5(b) is a cross-sectional view in the case where steel channels are arranged only on one side in Fig. 4(a).

Fig. 6 is a cross-sectional view showing another example of a viscoelastic brace of the present invention.

Fig. 7 is a view showing an example of a conventional vibration control device, wherein Fig. 7(a) is a view showing a concept of attaching the device, and Fig. 7(b) is a view showing an concept of the vibration control device and also Fig. 7(b) is a cross-sectional view of the vibration control device.

Fig. 8 is a view showing another example of the conventional vibration control device, wherein Fig. 8(a) is a view showing a concept of attaching the device, and Figs. 8(b) and 8(c) are cross-sectional views of

different vibration control devices for controlling vibration of a building.

Fig. 9(a), (b) and (c) are a view showing a comparison of a radius of gyration of area in Embodiment 1, wherein Fig. 9(a) is a view showing a radius of gyration of area of a steel channel, Fig. 9(b) is a view showing a radius of gyration of area of a semi-circular steel plate and Fig. 9(c) is a view showing a radius of gyration of area a flat steel plate.

Fig. 10(a), (b) and (c) are a view showing a comparison of a radius of gyration of area in Embodiment 2, wherein Fig. 10(a) is a view showing a radius of gyration of area of a steel channel, Fig. 10(b) is a view showing a radius of gyration of area of a semi-circular steel plate and Fig. 10(c) is a view showing a radius of gyration of area of a flat steel plate.

THE MOST PREFERRED EMBODIMENTS

In the present invention, the first core member is provided on its side surfaces with a single layer or a plurality of layers of steel channels or semi-circular steel plates which are opposed surrounding the first core member, and a single layer or a plurality of layers of viscoelastic sheets laminated thereon. The steel channels or semi-circular steel plates are alternately secured at one end thereof to an end of the first core member and the second core member. The first and the second core member are connected with each other via an extension or contraction space therebetween by the steel channels or the semi-circular steel plates and the viscoelastic sheets. Due to the above structure, when vibration energy is inputted into the viscoelastic brace, it is absorbed by the shearing deformation of the viscoelastic sheets.

In this case, radiuses of gyration of area of the steel channels and the semi-circular steel plates on which the viscoelastic sheets are laminated are large.

Therefore, even if a compression force is given to the viscoelastic brace, there is no possibility of the occurrence of buckling, and the force can be stably transmitted. When a cover is made to adhere to the sides
5 of the outermost steel channels or the semi-circular steel plates, which are arranged being opposed to each other, so that they can be connected with each other, the overall lamination structure is enclosed and restricted. Therefore, the viscoelastic sheets are not peeled off
10 from the steel channels or the semi-circular steel plates.

Due to the foregoing, a deformation caused in the horizontal direction and a shearing force given to a structure such as a high-rise building when it is
15 oscillated horizontally can be reduced, and vibration can be quickly damped.

The viscoelastic brace of the present invention is composed as described above. Therefore, it is possible to solve a problem caused in the prior art in which the
20 components of the vibration control device are buckled when a compression force is given to them. When the cover is made to adhere to the sides of the outermost steel channels or the semi-circular steel plates which are arranged being opposed to each other, they are
25 connected with each other. Due to the above structure, it is possible to solve a problem in which the viscoelastic sheets are peeled off from the steel plates, and further it becomes possible to interpose a remarkably larger number of sections of the viscoelastic sheets than
30 that of the prior art. Accordingly, it is possible to realize a viscoelastic brace of high performance by the present invention. From this viewpoint, it can be said that the novelty of the present invention is high.

35 EMBODIMENTS

Referring to the embodiments, the present invention will be explained in detail.

EMBODIMENT 1

Referring to Figs. 1 and 2, Embodiment 1 of the viscoelastic brace of the present invention will be explained below.

5 Figs. 1(a), 1(b) and 1(c) are views showing an example in which the viscoelastic brace of the present invention is applied to a brace of a high-rise building.

The viscoelastic brace 2 shown in Figs. 1(a), 1(b) and 1(c) is composed as follows. On the sides of the
10 first core member 3, the section of which is an H-shape, shown in Figs. 2(a) and 2(b), the first viscoelastic sheets 9 and the first steel channels 6, which are opposed to each other surrounding the first core member 3, are alternately laminated and made to adhere to each
15 other. End portions of the first steel channels 6 are fixed to the second core member 4, the section of which is an H-shape, via the first steel channel fixing member 13. In the first core member 3 and the second core member 4, there are formed a hole 15 for connecting the
20 first core member and a hole 16 for connecting the second core member, and these holes 15, 16 are used for fixing the viscoelastic brace to the frame 1 of a building shown in Fig. 1. The cover 17 is fixed onto the sides of the first steel channels 6 which are arranged being opposed
25 to each other. The first core member 3 and the second core member 4 are connected with each other by the first viscoelastic sheets 9 and the first steel channels 6 via the clearance 30 used for extension or contraction.

As shown in Figs. 2(c) and 2(d), the cross sections
30 of the first core member 3 and the second core member 4 may be angle steel pipes or round steel pipes. When the round steel pipes are used, the first semicircular steel plates 27 are used instead of the first steel channels 6.

When the clearance 30 used for extension or
35 contraction is interposed between the first core member 3 and the second core member 4, the first core member 3, the second core member 4 and the first steel channel 6

are not deformed by vibration energy inputted into the viscoelastic brace 2, and shearing deformation can be caused only in the first viscoelastic sheets 9.

As shown in Figs. 9(a), 9(b) and 9(c), when
5 thicknesses t and widths B of the first steel channel 6, the first semi-circular steel plate 27 and the first flat steel plate 31 are made to be the same, moment of inertia of area I_1 and I_2 of the first steel channel 6 and the first semi-circular steel plate 27 around neutral axis X
10 - X become approximately 150 to 160 times as high as that of moment of inertia of area I_3 of the first flat steel plate 31. Accordingly, radiuses of gyration of area i_1 and i_2 of the first steel channels 6 and the first semi-circular steel plate 27 become 9 to 10 times as large as
15 radius of gyration of area i_3 of the first flat steel plate 31. Therefore, when a compression force in the axial direction is given to the viscoelastic brace, it is possible to prevent the occurrence of buckling. When the covers 17 are arranged being opposed to each other so
20 that the sides of the first steel channels can be fastened to the covers, the first steel channels 6, the first viscoelastic sheets 9 and the first core member 3 are restricted, and they are prevented from peeling off from each other. Therefore, a force given to the
25 viscoelastic brace can be stably transmitted.

As shown in Fig. 2, when the above viscoelastic brace 2 shown in Fig. 1 is fixed to the frame 1 of a building by bolts and others using the first core member connecting hole 15 and the second core member connecting
30 hole 16, vibration energy inputted into the frame 1 of the building is absorbed by a shearing deformation of the first viscoelastic sheets 9.

For example, as shown in Fig. 2, when length of adhesion of the viscoelastic sheet 9, which has been made
35 to adhere onto the side of the first core member 3, is the same as the overall length of the core member except for the connecting section, a shearing area of the

viscoelastic sheet 9 becomes 5 times as large as that of the prior art shown in Fig. 8 in which the vibration control device 115 (116) having one layer of viscoelastic sheet at the end portion is attached. Therefore, the vibration energy absorbing capacity is enhanced by 5 times. Due to the foregoing, vibration of the frame 1 of a building is quickly damped, and the viscoelastic brace 2 can exhibit an excellent effect of damping.

EMBODIMENT 2

Referring to Fig. 3, Embodiment 2 of the viscoelastic brace of the present invention will be explained below.

The viscoelastic brace 2 of Embodiment 2 shown in Figs. 3(a) and 3(b) is different from that of Embodiment 1 shown in Fig. 2 as follows. On the sides of the first core member 3, the section of which is an H-shape, shown in Figs. 3(a) and 3(b), the first viscoelastic sheets 9 which are opposed to each other surrounding the first core member 3, the first steel channels 6, the second viscoelastic sheets 10, the second steel channels 7, the third viscoelastic sheets 11 and the third steel channels 8 are alternately laminated and made to adhere to each other. The first steel channels 13 are interposed at an end portion of the first steel channel 6, and further end portions of the third steel channels 8 are fixed to the second core member 4, the section of which is an H-shape, via the third steel channel fixing members 14. End portions of the second steel channels 7 are fixed to the first core member 3, the section of which is an H-shape, via the second steel channel fixing member 12. The first core member 3 and the second core member 4 are connected with each other by the first viscoelastic sheets 9, the first steel channels 6, the second viscoelastic sheets 10, the second steel channels 7, the third viscoelastic sheets 11, and the third steel channels 8. The covers 17 are fixed to the sides of the third steel channels 8 which are arranged being opposed to each other.

That is, in the viscoelastic brace 2 shown in Fig. 2, a set of the first viscoelastic sheets 9 and the first steel channels 6 are formed into one layer structure. On the other hand, in the viscoelastic brace 2 shown in Fig. 3, a set of the first viscoelastic sheets 9 and the first steel channels 6, a set of the second viscoelastic sheets 10 and the second steel channels 7 and a set of the third viscoelastic sheets 11 and the third steel channels 8 are formed into three layers.

The above structure is not limited to the three layer structure, but the number of layers may be increased by combining the viscoelastic sheets with the steel channels.

Cross-sections of the first core member 3 and the second core member 4 may be an angle steel pipe or a round steel pipe shown in Figs. 3(c) and 3(d). In the case of the round steel pipes, instead of the first steel channels 6, the second steel channels 7 and the third steel channels 8, it is possible to use the first semi-circular steel plates 27, the second semi-circular steel plates 28 and the third semi-circular steels plates 29.

As shown in Figs. 10(a), 10(b) and 10(c), when thicknesses t and widths B of the first steel channel 6, the first semi-circular steel plate 27 and the first flat steel plate 31 are made to be the same, moment of inertia of area I_1 and I_2 of the first steel channel 6 and the first semi-circular steel plate 27 around neutral axis $X_1 - X_1$ become approximately 150 to 160 times as high as moment of inertia of area I_3 of the first flat steel plate 31. Accordingly, radiuses of gyration of area i_1 and i_2 of the first steel channels 6 and the first semi-circular steel plate 27 become 9 to 10 times as large as radius of gyration of area i_3 of the first flat steel plate 31. Therefore, when a compression force in the axial direction is given to the viscoelastic brace, it is possible to prevent the occurrence of buckling.

In the same manner, radiuses of gyration of area of

the second steel channels 7, the third steel channels 8, the second round steel plates 28 and the third semi-circular steel plates 29 are larger than those of the second flat steel plates 32 and the third flat steel plates 33. Therefore, buckling is not caused when a compression force is given to the viscoelastic brace of this embodiment.

Since the overall laminated layer is restricted by the outermost layer of the steel plate 8 or 29 and the cover 17, the viscoelastic sheets are not peeled off from the steel channels. Therefore, a force given to the viscoelastic brace can be stably transmitted.

In Embodiment 2, three layers of viscoelastic sheets are laminated and made to adhere onto the sides of the first core member 3. Therefore, when Embodiment 2 is compared with Embodiment 1 in which a single layer of viscoelastic sheets are laminated and made to adhere onto the sides of the first core member 3, the vibration energy absorbing capacity is increased by three times. Due to the above structure, it becomes possible to form a viscoelastic brace 2 of a large capacity in which vibration energy inputted into the frame 1 of a building can be absorbed by the shearing deformation of the viscoelastic sheets. Accordingly, it is possible to provide a more effective damping effect than that of Embodiment 1.

EMBODIMENT 3

Referring to Figs. 4 and 5, Embodiment 3 of the viscoelastic brace of the present invention will be explained below. The viscoelastic brace 2 of Embodiment 3 shown in Figs. 4(a) and 4(b) and Fig. 5(a) is different from that of Embodiment 2 shown in Figs. 3(a) and 3(b) as follows. On the web sides of the first core member 3, the section of which is an H-shape, shown in Fig. 5(a), the first inner viscoelastic sheets 21, the first inner steel channels 19, the second inner viscoelastic sheets 22, and the second inner steel channels 20, which are

opposed to each other with respect to the web of the first core member 3, are alternately laminated and made to adhere to each other. End portions of the first inner steel channels 19 are fixed to the second core member 4, the section of which is an H-shape, via the first inner steel channel fixing member 23, and end portions of the second inner steel channels 20 are fixed to the first core member 3, the section of which is an H-shape, via the second inner steel channel fixing member 24. The first core member 3 and the second core member 4 are connected with each other by the first viscoelastic sheets 9, the first steel channels 6, the second viscoelastic sheets 10, the second steel channels 7, the third viscoelastic sheets 11, the third steel channels 8, the first inner viscoelastic sheets 21, the first inner steel channels 19, the second inner viscoelastic sheets 22, and the second inner steel channels 20.

That is, the viscoelastic brace 2 of Embodiment 3 shown in Figs. 4(a), 4(b) and 5(a) is composed in such a manner that a lamination structure including the viscoelastic sheets and steel channels is added to both sides of the web of the first core member 3 of the viscoelastic brace 2 of Embodiment 2 shown in Figs. 3(a) and 3(b). In this connection, in the present invention, at least one of the sets of steel channels or semi-circular steel plates and viscoelastic sheets, which are arranged opposed to each other, may be arranged only on one side as shown in Fig. 5(b).

The present invention is not limited to the above lamination structure, but the number of combinations of the viscoelastic sheets with the steel channels may be increased so that the number of the viscoelastic layers can be increased.

Compared with Embodiment 2, this Embodiment 3 is advantageous as follows. In Embodiment 3, four layers of viscoelastic sheets, which are laminated and made to adhere to the sides of the web of the first core member

3, are added. According to the sectional area of shearing of the thus added four viscoelastic sheets, a capacity of absorbing vibration energy can be increased.

5 As shown in Fig. 6, a variation of the present invention may be provided, which comprises: a first core member and a second core member made of H sections, I sections, assembled members of H sections and assembled members of I sections, the first core member and the second core member being arranged along a line to define
10 an extension or contraction space therebetween; and a single layer of a set of steel channels and viscoelastic sheets, which are opposed to each other, provided being laminated on the side surfaces of the web of the first core member, wherein end portions of the steel channels are made to adhere to the second core member, and the
15 first and the second core member are viscoelastically connected with each other through the steel channels and the viscoelastic sheets. Instead of the single layer of the steel channel and the viscoelastic sheet incorporated into this viscoelastic brace, it is possible to adopt a structure in which a plurality of sets of steel channels and viscoelastic sheets are opposed to each other being arranged on the sides of the web, a plurality of sets of steel channels and viscoelastic sheets are alternately
20 laminated and made to adhere to each other, and the end portions of the steel channels are alternately made to adhere to a portion in the proximity of the end of the second core member or the first core member. When the above structure is adopted, it is unnecessary that a single layer or a plurality of layers of sets of steel channels and viscoelastic sheets are laminated and made to adhere to each other. Therefore, the structure of the viscoelastic brace can be simplified. Even if the structure is simplified, the viscoelastic brace can be
25 put into practical use without causing any problem.
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As described above, when the viscoelastic sheets and the steel channels are laminated and made to adhere onto

both sides of the first core member 3, the section of which is an H-shape, it is possible to form a viscoelastic brace 2 of a larger capacity to absorb vibration energy.

5 Due to the above structure of Embodiment 3, vibration energy inputted into the frame 1 of a building can be absorbed by the shearing deformation of the viscoelastic sheets more effectively than the structure of Embodiment 2. Accordingly, it is possible to obtain a
10 high damping effect. According to the present invention, vibration of the frame 1 of a building can be quickly damped, that is, the viscoelastic brace 2 can exhibit an excellent damping effect.

15 INDUSTRIAL POSSIBILITY

 As explained above, according to the present invention, since the radius of gyration of area of the steel channel or the semi-circular steel plate on which the viscoelastic sheet is laminated is large, no buckling
20 is caused in the case where a compression force is given to the viscoelastic brace, and the force is stably transmitted. When the cover is fixed to the sides of the outermost steel channels or the semi-circular steel plates, which are arranged being opposed to each other,
25 the overall lamination structure is enclosed and restricted. Therefore, the viscoelastic sheets are not peeled off from the steel channels or the semi-circular steel plates. Since the steel channels or the semi-circular steel plates are arranged being separate from
30 and opposed to each other, it is possible to manufacture the viscoelastic brace in such a manner that the viscoelastic sheets and the steel channels or the semi-circular steel plates are laminated and pressed so that they can be made to adhere to each other, that is, it is
35 unnecessary to pour a viscoelastic material. When viscoelastic material which can not be poured is used, a viscoelastic brace can be effectively manufactured.

Therefore, in a building such as a high-rise building in which the height of the building is larger than the width, a deformation and shearing force in the horizontal direction caused by an earthquake and wind can be reduced and vibration can be quickly damped.

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What is claimed is:

1. A viscoelastic brace comprising: a first core member and a second core member made of shape steel, an angle steel pipe or round steel pipe, the first core member and the second core member being arranged along a line to define an extension or contraction space therebetween; a single layer of a set of steel channels or semi-circular steel plates, which are opposed to each other surrounding the first core member, provided being laminated on the side surfaces of the first core member; and a single layer of viscoelastic sheet provided being laminated on the side surfaces of the first core member, wherein the steel channels or semi-circular steel plates are secured at an end of the second core member, and the first and the second core member are viscoelastically connected with each other through the steel channels or the semi-circular steel plates and the viscoelastic sheets.
2. A viscoelastic brace according to claim 1, wherein a plurality of sets of steel channels or semi-circular steel plates which are opposed to each other and a plurality of viscoelastic sheets are arranged and laminated and made to adhere to each other, and end portions of the steel channels or semi-circular steel plates are alternately made to adhere to a portion in the proximity of the end portion of the second or the first core member.
3. A viscoelastic brace according to claim 1 or 2, wherein a cover is made to adhere to the outermost steel channels or semi-circular steel plates, by which a side of one of the outermost steel channels or semi-circular steel plates which are opposed to each other and a side of the other of the outermost steel channels or semi-circular steel plates which are opposed to each other are connected with each other.
4. A viscoelastic brace according to one of claims 1 to 3, wherein the steel channels or the semi-circular



steel plates which are opposed to each other are arranged at predetermined intervals.

5. A viscoelastic brace according to one of claims 1 to 4, wherein the steel channels composing the first and the second core member are one of H sections, I sections, assembled members of H sections and assembled members of I sections, a single layer of one set of steel channels which are opposed to each other and also a single layer of viscoelastic sheet are laminated and made to adhere onto a side of the web of the first core member, and end portions of the steel channels which are opposed to each other being arranged on the side of the web are made to adhere to the second core member.

6. A viscoelastic brace according to claim 5, wherein a plurality of sets of steel channels and viscoelastic sheets are opposed to each other being arranged on the sides of the web, a plurality of sets of steel channels and viscoelastic sheets are alternately laminated and made to adhere to each other, and the end portions of the steel channels are alternately made to adhere to a portion in the proximity of the end of the second core member or the first core member.

7. A viscoelastic brace comprising: a first core member and a second core member made of H sections, I sections, assembled members of H sections and assembled members of I sections, the first core member and the second core member being arranged along a line to define an extension or contraction space therebetween; and a single layer of a set of steel channels and viscoelastic sheets, which are opposed to each other, provided being laminated on the side surfaces of the web of the first core member, wherein end portions of the steel channels are made to adhere to the second core member, and the first and the second core member are viscoelastically connected with each other through the steel channels and the viscoelastic sheets.

8. A viscoelastic brace according to claim 7,





wherein a plurality of sets of steel channels and viscoelastic sheets are opposed to each other being arranged on the sides of the web, a plurality of sets of steel channels and viscoelastic sheets are alternately laminated and made to adhere to each other, and the end portions of the steel channels are alternately made to adhere to a portion in the proximity of the end of the second core member or the first core member.

9. A viscoelastic brace according to one of claims 1 to 8, wherein at least one set of the plurality of sets of steel grooves or semi-circular steel plates which are opposed to each other and viscoelastic sheets provided thereon are arranged only on one side.

This Sheet Has Been Replaced



THIS SHEET HAS BEEN
REPLACED