HEALD FRAME STAVE CONSTITUTED OF CARBON-FIBER-REINFORCED COMPOSITE MATERIAL, AND MOUNTING PART STRUCTURE FOR SIDE STAY

There are provided a heald frame stave made of carbon fiber reinforced composite material, and a side stay attaching part structure for coupling a frame stave and a side stay with each other, which can achieve speed-up and vibration-isolating property of a loom owning to weight reduction and high rigidity and can be assembled and disassembled easily. A heald frame stave 2 made of carbon fiber reinforced composite material is provided with both side plates 11a and 11b made of carbon fiber reinforced composite material, an upper plate 10a and a lower plate 10b made of carbon fiber reinforced composite material and coupling, along a longitudinal direction, upper ends of the both side plates 11a and 11b with each other and lower ends thereof with each other, and first metal-made bars 20 for attachment of a side stay 3 integrally attached on a lower face of the upper plate 10a at both end portions of the upper plate 10a in the longitudinal direction, respectively, wherein the upper plate 10a and the lower plate 10b are produced from unidirectional carbon fiber reinforced composite material and thicknesses thereof in a vertical direction perpendicular to the longitudinal direction are in a range of 5 mm or more to 20 mm or less.
Description

Technical Field

[0001] The present invention relates generally to a structure of a heald frame used in a loom, and more particularly to a heald frame stave made of carbon fiber reinforced composite material and a side stay attaching part structure for coupling a heald frame stave made of carbon fiber reinforced composite material and a side stay with each other.

Background Art

[0002] A heald frame is a member for supporting a heald for letting a warp go through in a loom, and is for alternately moving a pair of heald frames in a vertical direction to open warps and drive a weft into the opening at a weaving time.

[0003] As one example is shown in Figure 1, a heald frame 1 generally has upper and lower frame staves extending in a longitudinal direction (in a direction of arrow A), namely, both frame main bodies 2, and side stays 3 arranged at both ends of both the frame main bodies 2 in the longitudinal direction and coupling both the frame main bodies 2 with each other. Supporting projection portions 5 for a hook hanger supporting a heald 4 along the longitudinal direction of the frame main bodies 2 are integrally formed at one end side of the frame main bodies 2 opposed to each other in a short-side direction (in a direction of arrow B) perpendicular to the lengthwise direction of the frame main bodies 2.

[0004] Further, the frame main bodies 2 and the side stays 3 are generally connected to each other by coupling portions 6 in a detachable structure. Besides, guide plates 7 for preventing the heald frames 1 from interfering with each other and couplings 8 positioned at portions transmitting power of vertical movement to the heald frame 1 are attached to the heald frame 1.

[0005] Most frame main bodies 2 are currently made of aluminum, and in the case of the aluminum-made frame main body 2, a hollow structure is adopted, as shown in Figure 2, but the hollow structure is a structure having several lateral ribs 21 in order to exert strength of the hollow portion thereof.

[0006] However, when a weaving speed of the loom is increased, the strength of aluminum, especially, the fatigue strength thereof cannot be maintained, so that replacement of the frame main body 2 is forced since the frame main body 2 cannot withstand continuous use thereof at the utmost in a period of half a year in the current situation.

[0007] In recent years, various head frames made of light-weight fiber-reinforced composite material (FRP) have been proposed in order to respond to increase in speed of a loom.

[0008] For example, a joining method between an FRP-made frame stave and a side stay has been disclosed in Patent Literature 1, and a structure where replacement of a part such as a broken or worn middle hook hanger, a broken or worn rod receiving part or the like is facilitated while rigidity and strength of an FRP-made heald frame are being maintained has been proposed in Patent Literature 2.

[0009] Speed-up or widening of a loom currently becomes world-wide trend, and the widening has already achieved up to manufacture of a loom with a width, namely, a longitudinal length in a direction perpendicular to a drawing sheet showing Figure 2 exceeding 3500mm. A frame main body of this machine type is made of aluminum, but load acting on the frame main body increases due to the widening, and strength or rigidity of the frame main body cannot follow the increase of the load sufficiently, so that increase in speed results in breakage of the frame main body. Therefore, there is such an actual condition that weaving with increased speed cannot be performed and a merit obtained by the widening cannot be enjoyed.

[0010] On the other hand, a frame main body using fiber-reinforced composite material using carbon fibers as reinforcing fibers, namely, CFRP has been proposed, and CFRP is used in some parts of a frame main body, but because strength or rigidity of a product is insufficient, there is such an actual condition that CFRP is applied to only frame main bodies with a width of about 1500 mm. The reason is because even if the frame main body is decreased in weight, the speed of the loom cannot be increased due to lack in strength or rigidity.

[0011] That is, one of the reasons why, though being made of CFRP, the frame main body cannot respond to the widening due to lack in strength or rigidity is because, since the heald frame structure made of CFRP is a hollow structure or a structure only including foamed material therein, sufficient strength cannot be secured, especially, it is difficult to secure fatigue strength. Therefore, CFRP is currently used only in looms with a narrow width, and sufficient speed-up cannot be achieved.

[0012] If a solid structure is adopted in order to secure strength or rigidity of the CFRP-made heald frame, an effect corresponding to the structure can be obtained, but the CFRP-made heald frame becomes heavier in weight than the aluminum-made heald frame and cost thereof is increased so that a merit of using the CFRP-made heald frame can be hardly obtained.

[0013] Therefore, the present inventors proposed a heald frame made of fiber-reinforced composite material in Patent Literature 3 in order to provide a heald frame made of fiber-reinforced composite material which can exert a maximum strength and rigidity within a limited structure and has a configuration reduced in weight and robust over fatigue strength, thereby being capable of improving productivity of a widened loom which could not have been achieved before now largely.

[0014] A schematic configuration of the heald frame made of fiber-reinforced composite material described in Patent Literature 3 is shown in Figure 3. In this example,
the heald frame made of fiber-reinforced composite material has an approximately flat plate-shaped frame main body 2 formed in an elongated shape and extending in a longitudinal direction (having a length L) and a supporting projection 5 continuously connected to a lower end of the frame main body 2 integrally along the longitudinal direction thereof. The frame main body 2 has a honeycomb structure 4 in its inner layer, and long fiber-reinforced composite materials 11 (11a, 11b) serving as surface layers are arranged on both faces of the inner layer in an aspect of sandwiching the honeycomb structure 4 of the inner layer. Further, reinforced portions 9 are formed in a portion or a whole of peripheral end faces of the honeycomb structure 4 of the inner layer by packing short fiber-reinforced composite material, resin, or foamed material into the honeycomb structure 4 in a range of a width of 3mm to 30mm.

However, in the heald frame proposed in Patent Literature 3, a conventional system, for example, such a system as shown in Patent Literature 1 must be adopted at a coupling time with side stays. In such a system, insertion of fittings for coupling must be performed, so that complicated work such as removal of the honeycomb or connection of fittings are required, which results in increase in cost.

Further, since the conventional coupling method is a system using various kinds of fittings to perform coupling, weights of the coupling portions become heavy so that a merit of weight reduction is halved.

In view of these circumstances, the present inventors proposed a heald frame made of fiber-reinforced composite material shown in Patent Literature 4. Figure 4 shows a whole configuration of a frame main body 2. In this example, the frame main body 2 is configured to be similar to the frame main body 2 of Patent Literature 3 shown in the above Figure 3, and has a honeycomb structure 9 in an inner layer, where long fiber-reinforced composite materials 11 (11a, 11b) are arranged on surface layers and a reinforced portion 10 is formed in a portion or a whole of peripheral end faces of the honeycomb structure 9 of the inner layer by packing short fiber-reinforced composite material, resin, or foamed material into a honeycomb structure 4 in a range of a width of 3mm to 30mm. In this example, however, as shown in Figure 4, the frame main body 2 is configured to be fixed by inserting side stay attaching portions 60 formed at both side portions of the frame main body 2 into grooves 3A of side stays 3.

Summary of the Invention

Problem to be solved by the Invention

A heald frame made of fiber-reinforced composite material such as described in the above Patent Literature 4 has such a feature that not only bending strength or bending elastic modulus of the frame main body 2 is improved largely but also reinforcement regarding stress concentration on an end face of the frame main body 2 is achieved and robustness to bending fatigue is achieved, so that in a widened loom weaving speed exceeding a conventional weaving speed is not only achieved but also continuous weaving time is improved largely.

An object of making a heald frame stave which is the frame main body from carbon fiber reinforced composite material in the heald frame lies in achievement of speed-up and vibration-isolating property of a loom owing to weight reduction and high rigidity. Of course, it is essential to achieve response to length elongation and quality improvement.

In order to achieve the above object, it is important to perform how to arrange carbon fiber reinforced composite material (CFRP) within a limited sectional shape effectively and how to perform assembling effectively.

In view of these viewpoints, the present invention is obtained by further developing the heald frame made of fiber reinforced composite material.

An object of the present invention is to provide a heald frame stave made of carbon fiber reinforced composite material which can achieve speed-up and vibration-isolating property of a loom owing to weight reduction and high rigidity and can be assembled and disassembled easily, and a side stay attaching part structure for coupling a frame stave and a side stay with each other.

Means for solving the Problem

The above object can be achieved by a heald frame stave made of carbon fiber reinforced composite material and a side stay attaching part structure for coupling a frame stave and a side stay with each other according to the present invention. Briefly speaking, according to a first aspect of the present invention, there is provided a heald frame stave made of carbon fiber reinforced composite material and having a hollow structure which is formed in an elongated shape, extends in a longitudinal direction thereof, and is attached with side stays at both end portions thereof in the longitudinal direction, comprising:
both side plates formed in a rectangular shape and made of carbon fiber reinforced composite material, and extending in the longitudinal direction; an upper plate and a lower plate made of carbon fiber reinforced composite material and coupling, along the longitudinal direction, upper ends of the both side plates with each other and lower ends thereof with each other; and first metal-made bars for attachment of the side stays, which are integrally attached on a lower face of the upper plate at both end portions of the upper plate in the longitudinal direction, wherein the upper plate and the lower plate are made of unidirectional carbon fiber reinforced composite material produced by directing carbon fibers in a pulling fashion in the longitudinal direction, and thicknesses thereof in a vertical direction perpendicular to the longitudinal direction are in a range of 5 mm or more to 20 mm or less.

According to another embodiment of the first aspect of the present invention, a reinforcing plate is provided on a lower face of the upper plate between the two first metal-made bars attached at the both end portions of the upper plate in the longitudinal direction, respectively, and the reinforcing plate is made of unidirectional carbon fiber reinforced composite material produced by directing carbon fibers in a pulling fashion in the longitudinal direction, and a thickness thereof in a vertical direction perpendicular to the longitudinal direction is in a range of 5 mm or more to 20 mm or less.

According to another embodiment of the first aspect of the present invention, the side stay insertion portion is formed with a convex projection on an upper face thereof, a recessed groove engaged with the convex projection of the side stay insertion portion when the side stay insertion portion has been inserted into the heald frame stave is formed on a lower face of the first metal-made bar contacting with the upper face of the side stay insertion portion.

According to another embodiment of the second aspect of the present invention, the second metal-made bars are coupled to the both side plates by metal-made rivets, and the both side plates are formed with slits positioned between the first metal-made bar and the second metal-made bar and extending from the respective side ends of the both side plates in the longitudinal direction by a predetermined length.

According to another embodiment of the second aspect of the present invention, a recessed groove engaged with the convex projection of the side stay insertion portion when the side stay insertion portion has been inserted into the heald frame stave is formed on a lower face of the first metal-made bar contacting with the upper face of the side stay insertion portion.

According to another embodiment of the second aspect of the present invention, a reinforcing plate is provided on a lower face of the upper plate between the two first metal-made bars attached at the both end portions of the upper plate in the longitudinal direction, wherein the upper plate and the lower plate are made of unidirectional carbon fiber reinforced composite material produced by directing carbon fibers in a pulling fashion in the longitudinal direction, and a thickness thereof in a vertical direction perpendicular to the longitudinal direction is in a range of 5 mm or more to 20 mm or less.

According to another embodiment of the second aspect of the present invention, a side stay insertion portion has been inserted into the heald frame stave is formed on a lower face of the first metal-made bar contacting with the upper face of the side stay insertion portion.

According to another embodiment of the second aspect of the present invention, a side stay insertion portion is formed with a convex projection on an upper face thereof, and

According to another embodiment of the second aspect of the present invention, a side stay insertion portion is formed with a convex projection on an upper face thereof, and
second aspect of the present invention, the second metal-made bar is an L-shaped fixing member having a horizontal member having the screw hole screwed with the fixing bolt and a vertical member extending in a vertical direction to the horizontal member.

According to another embodiment of the second aspect of the present invention, a projection fitted in a groove formed on a lower face of the first metal-made bar or the moving metal-made bar for adjustment is formed on an upper face of the vertical member of the L-shaped fixing member.

According to another embodiment of the second aspect of the present invention, the side stay insertion portion is a plate-shaped member formed in an approximately rectangular shape and having a thickness fitted into the hollow portion of the heald frame stave, and a U-shaped groove is formed in the side stay insertion portion so as to extend in a vertical direction from a distal end portion opposed to the side stay main body to the side stay main body by a predetermined length and be opened at the distal end portion, the side stay insertion portion is inserted into the heald frame stave such that the U-shaped groove of the side stay insertion portion is fitted to the fixing bolt which has been inserted from the side of the upper plate, and the side frame which has been inserted into the heald frame stave is fixed by the fixing bolt and the second metal-made bar.

**Effect of the Invention**

According to the present invention, speed-up and vibration isolating property of a loom can be achieved owing to weight reduction and high rigidity, and assembling and disassembling are easy.

**Brief Description of the Drawings**

Figure 1 is a front view showing one example of a heald frame where the present invention is embodied;

Figure 2 is a sectional view of a heald frame stave made of aluminum;

Figure 3 is a perspective view showing one example of a heald frame stave made of fiber reinforced composite material;

Figure 4 is a perspective view showing one example of a side stay attaching part structure for coupling the heald frame stave made of fiber reinforced composite material and a side stay with each other;

Figure 5 is a perspective view of one embodiment of a heald frame stave made of carbon fiber reinforced composite material according to the present invention;

Figure 6 (a) is a sectional view of an embodiment of a heald frame stave made of carbon fiber reinforced composite material according to the present invention, and Figure 6 (b) is a sectional view of another embodiment of the heald frame stave made of carbon fiber reinforced composite material according to the present invention;

Figure 7(a) is a perspective view for explaining an embodiment of a side stay attaching part structure according to the present invention, and Figure 7(b) is a partially-enlarged perspective view of the side stay attaching part structure shown in Figure 7(a);

Figure 8 is a perspective view showing another embodiment of the a heald frame stave made of carbon fiber reinforced composite material according to the present invention;

Figure 9 is a perspective view of another embodiment of the a heald frame stave made of carbon fiber reinforced composite material according to the present invention;

Figure 10 is a view for explaining another embodiment of the side stay attaching part structure according to the present invention, Figure 10(a) being perspective view showing the whole of the side stay attaching part structure and Figure 10(b) being a partially-enlarged perspective view of the side stay attaching part structure shown in Figure 10(a);

Figure 11 is a view for explaining another embodiment of the side stay attaching part structure according to the present invention, Figure 11 (a) being a perspective view showing the whole of the side stay attaching part structure and Figure 11(b) and Figure 11(c) being partially-enlarged perspective views of the side stay attaching part structure shown in Figure 11(a);

Figure 12 is a view for explaining another embodiment of the side stay attaching part structure according to the present invention, Figure 12(a) being a perspective view showing the whole of the side stay attaching part structure and Figure 12(b) being a partially-enlarged perspective view of the side stay attaching part structure shown in Figure 12(a);

Figure 13 is a view for explaining another embodiment of the side stay attaching part structure according to the present invention, Figure 13(a) being a perspective view showing the whole of the side stay attaching part structure, and Figure 13(b) and Figure 13(c) being partially-enlarged perspective views of the side stay attaching part structure shown in Figure 13(a);

Figure 14 is a perspective view for explaining another embodiment of the side stay attaching part structure according to the present invention;

Figure 15 is a view for explaining another embodiment of the side stay attaching part structure according to the present invention, Figure 15(a) being a perspective view showing the whole of the side stay attaching part structure, Figure 15(b) being a partially-enlarged perspective view of the side stay attaching part structure shown in Figure 15(a), and Figure
15(c) being a front view; Figure 16 is a front view for explaining another embodiment of the side stay attaching part structure according to the present invention;

Figure 17 is a view for explaining another embodiment of the side stay attaching part structure according to the present invention; Figure 17(a) being a perspective view showing the whole of the side stay attaching part structure and Figure 17(b) being a partially-enlarged perspective view of the side stay attaching part structure shown in Figure 17(a); Figure 18 is a view for explaining another embodiment of the side stay attaching part structure according to the present invention, Figure 18(a) being a perspective view showing the whole of the side stay attaching part structure, Figure 18(b) being a partially-enlarged perspective view of the side stay attaching part structure shown in Figure 18(a), and Figure 18(c) being a front view;

Figure 19 is a front view for explaining another embodiment of the side stay attaching part structure according to the present invention; and Figure 20 is a view for explaining another embodiment of the side stay attaching part structure according to the present invention, Figure 20(a) being a perspective view showing the whole of the side stay attaching part structure and Figure 20(b) being a partially-enlarged perspective view of the side stay attaching part structure shown in Figure 20(a).

Embodiment for carrying out the Invention

A heald frame stave made of carbon fiber reinforced composite material and a side stay attaching part structure for coupling a heald frame stave and a side stay with each other according to the present invention will be described further in detail with reference to the drawings.

Embodiment 1

(Whole Configuration of Heald Frame)

Figure 5, Figure 6, and Figure 7 are schematic configuration of an embodiment of a heald frame stave 2 made of carbon fiber reinforced composite material according to the present invention. Figure 5 and Figure 6 are a perspective view and cross-sectional views showing an upper frame heald frame stave 2, namely, an upper-side frame main body 2 having a hollow structure, constituting a heald frame 1 made of fiber-reinforced composite material (see Figure 1), respectively. Figure 7 is a perspective view showing the frame main body 2 and a portion of a side stay 3 positioned on a side portion of the frame main body 2 in a longitudinal direction of the frame main body 2.

In the following description, Y direction is called "vertical direction (or short-side direction) and X direction is called "horizontal direction (or longitudinal direction) in Figure 5 for simple explanation such that the configuration of the heald frame stave 2 of this embodiment can be understood better.

In this embodiment, a heald frame has a whole configuration similar to the configuration of the conventional heald frame 1 shown in Figure 1, and it is provided with a frame stave 2 having a hollow structure which is a frame main body formed in an elongated shape and extending in a longitudinal direction and side stays 3 integrally provided at both side portions of the frame main body 2 in the longitudinal direction.

As shown in Figure 5, the frame main body 2 has a hollow structure portion 2A constituted as a hollow structure, and a supporting projection portion for hook hanger 5 supporting the heald 4 (see Figure 1) along a longitudinal direction of the frame main body 2 is formed on one end side of the hollow structure portion 2A in a short-side direction perpendicular to the longitudinal direction of the hollow structure portion 2A, namely, a lower end edge side of the frame main body 2 extending along the longitudinal direction thereof.

Further, upper ends of the frame main body 2 on both end portions in the longitudinal direction of the frame main body 2 are constituted as structures for coupling the side stay 3 and the frame main body 2, namely, side stay attaching part structures 60, as shown in Figure 7.

In the heald frame 1 made of fiber-reinforced composite material of this embodiment, the hollow structure portion 2A of the frame main body 2 is composed of rectangular both side plates 11 (11a, 11b) extending in the longitudinal direction and lateral ribs 10 coupling upper ends of the both side plates 11a and 11b with each other and lower ends thereof with each other, namely, an upper plate 10a and a lower plate 10b, as shown in Figure 5 and Figure 6(a).

According to the present invention, side stay fixing members made of metal, namely, a metal-made bar (first metal-made bar) 20 made of, for example, steel, stainless steel, copper, or aluminum are provided on a lower face of the upper plate 10 at both end portions of the upper plate 10a in the longitudinal direction in order to configure side stay attaching part structures 60. In this embodiment, the metal-made bar 20 has a rectangular shape in a cross section and a width T20 thereof is set to a distance T3 between inner faces of the both side plates 11a and 11b, and the metal-made bar 20 is disposed inside a space between the both side plates 11a and 11b. A length (L20) of the metal-made bar 20 extending along the longitudinal direction of the side plates 11 is set to a predetermined length, for example, 3 to 8 cm, generally, about 5cm. A thickness (H3) of the metal-made bar 20 is set to 5 to 10 mm, generally, about 5 mm. The metal-made bar 20 is fixed to the upper plate 10a positioned on an upper side by adhesive agent. Further, the metal-made bar 20 can be joined to the both side plates 11 (11a, 11b) by rivets 22 made of metal, for example, steel, stainless steel, copper, or aluminum and
penetrating side faces of the metal-made bar 20 from the both side plate sides, as shown in Figure 8.

Furthermore, as shown in Figure 9, an additional lateral rib (namely, a reinforcing plate) 10c composed of carbon fiber-reinforcing composite material and having a constitution similar to that of the upper plate 10a may be fixed to a lower face of the upper plate 10a between the metal-made bars 20 and 20 constituting the side stay fixing portions arranged at both end portions of the frame main body 2 in the longitudinal direction thereof by adhesion or the like.

With reference to Figure 5 and Figure 6(a), the supporting projection portion 5 integrally formed on the lower portion of the frame main body 2 is composed of a rectangular supporting plate 5a integrally formed together with the side plate 11a along a lower end edge of the side plate 11a positioned on one side of the frame main body 2 in the longitudinal direction, and a projection portion 5b formed adjacent to a lower end of the supporting plate 5a and having a rectangle in cross-sectional shape. In fact, though described later in detail, as shown in Figure 6(b), the supporting plate 5a can be formed by further extending the side walls 11a and 11b of the frame main body 2 downward and joining them so as to surround a projecting material 5c at lower ends thereof.

The hollow structure portion 2A of the frame main body 2 formed in a hollow structure and further the supporting projecting portion 5 are substantially made of carbon fiber reinforced composite material. For easy understanding, as one example, specific sizes of the frame main body 2 in this embodiment are as follows:

A length W1 of the hollow structure portion 2A of the frame main body 2 in the vertical direction is set to 118 mm, while a length W2 of the supporting projection portion 5 in the vertical direction is set to 37 mm. That is, the width W of the whole frame main body 2 is set to 155 mm, and a length W3 in the vertical direction from the lower end of the frame main body 2, namely, the lower plate 10b, to the projection portion 5b is set to 25 mm. A length L of the frame main body 2 in the longitudinal direction can be set to a length exceeding 3500 mm, but it is set to 2374 mm in this embodiment. 3500 mm, but ordinarily, in a range of 50 to 60%.

Further, this embodiment, a size T1 between outer surfaces of the both side plates 11a and 11b is set to 9 mm, and a thickness T2 of each of the side plates 11a and 11b is set to 1 mm (namely, the distance T3 between the inner surfaces of the both side plates 11a and 11b is set to 7 mm). Further, a thickness T4 of the supporting plate 5a is set to 2 mm. In particular, the upper plate 10a and the lower plate 10b, and the reinforcing plate 10c of the frame main body 2 are made of unidirectional carbon fiber reinforced composite material formed by directing carbon fibers of long fibers in one direction to arrange them in the longitudinal direction, where thicknesses H1, H2 and H4 (Figure 9) are set in a range from 5 mm more to 20 mm or less (generally, 5 to 10 mm). In particular, regarding the upper plate 10a and the lower plate 10b, if their thicknesses are less than 5 mm, a required strength for the heald frame stave cannot be obtained. On the other hand, upper limit values of the thicknesses are 20 mm, but if the thicknesses exceed 20 mm, strengths of the upper plate 10a and the lower plate 10b are increased, but a merit regarding "weight reduction" of the heald frame stave which is an important factor of making the heald frame stave of the carbon fiber reinforced composite material is lost. That is, there is a possibility that the heald frame stave has the same weight as that of the conventional case having the heald frame stave made of aluminum. In this embodiment, considering the weight reduction, as the thicknesses H1 and H2 of the upper plate 10a and the lower plate 10b (and the thickness H4 of the reinforcing plate 10c used if necessary), 5 mm which is their lower limit values is adopted. Of course, the values of H1, H2, and H4 may be set to different values according to designing, respectively.

Next, respective members of the heald frame stave 2 made of carbon fiber reinforced composite material of this embodiment will be described in detail.

(Heald Frame Stave)

In the heald frame 1 made of fiber-reinforced composite material 1 of this embodiment, as an aspect of the long fibers used in the carbon fiber reinforced composite material forming the frame main body 2 formed in the hollow structure, namely, the both side plates 11 (11a, 11b) of the heald frame stave 2, an UD shape where the fibers have been directed in one direction in a pulling fashion, a plain weave or satin weave shape woven biaxially, or a triaxial weave shape woven triaxially can be used alone, or a plurality of them are used in a combined fashion. The upper plate 10a and the lower plate 10b serving as the lateral ribs 10 (and the reinforcing plate 10c) take the UD shape where the fibers have been directed in one direction in a pulling fashion, as described above.

Further, as matrix resin used in the carbon fiber reinforced composite material, any of epoxy resin, unsaturated polyester resin, vinyl ester resin, MMA resin, and phenol resin can be used.

The volume fraction of fiber of the carbon fiber reinforced composite material is in a range of 30 to 70%, ordinarily, in a range of 50 to 60%.

(Heald Frame Stave)

As shown in Figure 6(b), according to this embodiment, the supporting plate 5a of the supporting projection portion for hook hanger 5 integrally provided to continuously connect to the frame main body 2 is formed by causing the carbon fiber reinforced composite materials forming the both side plates 11 (11a, 11b) of the frame main body 2 to adhere to each other. Further, a distal end portion of the supporting projection portion 5 has a projection 5b having a predetermined shape for functioning as a hook hanger. The projection 5b can be
such as long fiber-reinforced composite material, short fiber-reinforced composite material, resin, or resin-foamed material between the carbon fiber reinforced composite materials 11a and 11b forming the supporting plate 5a. Reinforcing fiber constituting the projection material 5c is not limited to the carbon fiber but glass fiber, organic fiber or the like can be used.

(Side Stay attaching part structure)

[0057] As described above, the side stay attaching part structure 60 has the metal-made bar 20 arranged as a fixing member of the side stay 3 at an upper end of each of both side end portions of the frame main body 2.

[0058] Figures 7(a) and 7(b) show one embodiment of the side stay attaching part structure 60 for coupling the metal-made bar 20 provided at the right end of the frame main body 2 in the longitudinal direction thereof and the side stay 3 on the right side with each other. Another side stay 3 is also arranged on the left end of the frame main body 2 in the same manner as the right end and a similar side stay attaching part structure is configured, but the latter side stay attaching part structure is omitted in Figures 7(a) and 7(b).

[0059] As shown in Figure 7(a), the upper plate 10a and the metal-made bars 20 provided at both the ends of the frame main body 2 in the longitudinal direction thereof are formed with through-holes 12 and 21 coaxially extending from the upper plate 10a through the metal-made bars 20 in a vertical direction, respectively.

[0060] As shown in Figure 7(b), the metal-made bar 20 having a rectangular sectional shape is preferably formed with a recessed groove 22 having a rectangular cross section machined on a lower face of the metal-made bar 20 along the longitudinal direction.

[0061] On the other hand, the side stay 3 has a side stay main body 30 which is a metal-made member having a rectangular cross section and extending in the vertical direction, and an insertion portion 31 integrally formed at an upper end of the side stay main body 30 so as to project from an upper end thereof at a right angle and inserted into the frame main body hollow structure portion 2A to be attached to the frame main body 2. As a material for the side stay 3, namely, the side stay main body 30 and the insertion portion 31, steel, stainless steel, aluminum or the like is used.

[0062] The insertion portion 31 is a plate-shaped member which extends from the side stay main body 30 at a right angle by a predetermined length, for example, 30 to 80 mm, which can be attached to a side face hollow portion of the frame main body 2, and which is formed in an approximately-rectangular shape. The thickness T30 of the insertion portion 31 is set to 6 to 6.5 mm, which is slightly thinner than the side face hollow portion thickness T3 (T3 = 7 mm in this embodiment), and the height H30 thereof is set to 20 to 70 mm.

[0063] In this embodiment, a U-shaped groove 32 is formed at a distal end portion of the insertion portion 31 so as to extend from a distal end face positioned on the opposite side of the side stay main body 30 by a predetermined length (about 1/2 of L30) and extend through the insertion portion 31 in the vertical direction.

[0064] Further, it is preferred that a convex projection 33 having a cross-sectional shape suitable to be fitted in the groove 22 of the metal-made bar 20, namely, a rectangular shape in this embodiment, being formed on an upper face of the insertion portion 31 along the longitudinal direction from the side stay main body 31 in the direction of the groove 32 by a predetermined length (about 1/2 of L30) for fitting to the groove 22 formed in the above-described metal-made bar 20. Therefore, when the insertion portion 31 of the side stay 3 are plugged into the side end portion hollow portion of the frame main body 2, the convex projection 33 on the upper face of the insertion portion 31 of the side stay 3 is fitted in the groove 22 on the lower face of the metal-made bar 20, so that the side stay 3 is aligned and integrally attached to the side end portion of the frame main body 2 in the longitudinal direction.

[0065] Incidentally, according to this embodiment, as shown in Figure 10, a movable metal-made bar 40 serving as a second fixing member is arranged below the fixed metal-made bar (first metal-made bar) 20 serving as a first fixing member fixed to the upper plate 10a so as to be separated from the same by a predetermined distance.

[0066] The second metal-made bar 40 can be made of material similar to that of the first metal-made bar 20 and can have a dimension similar to the latter. However, the second metal-made bar 40 is formed with a screw hole 41 by machining. That is, the second metal-made bar 40 functions as a nut member for a side stay fixing bolt 38. Incidentally, the second metal-made bar 40 does not have a groove identical to the groove 22 formed in the first metal-made bar 20.

[0067] In this embodiment, with the above configuration, prior to insertion of the side stay 3 into the side portion of the hollow structure portion 2A of the frame main body 2, as shown in Figure 10(a), first, the side stay fixing bolt 38 is inserted from the upper plate 10a toward the first metal-made bar 20 to penetrate the through-holes 12 and 21 and screwed into the screw hole 41 of the second metal-made bar 40. Next, the insertion portion 31 of the side stay 31 is inserted into the hollow portion of the frame main body 2 so as to be sandwiched between the first metal-made bar 20 and the second metal-made bar 40 such that the shaft portion of the fixing bolt 38 is fitted into the U-shaped groove 32 of the insertion portion 31.

[0068] Thereby, the convex projection 33 on the upper face of the insertion portion 31 of the side stay 3 is fitted into the groove 22 of the metal-made bar 20, so that the side stay 3 is integrally attached to the side face of the frame main body 2. The lower face of the side stay insertion portion 31 is caused to abut on the upper face of
Furthermore, in the modified embodiment 1-1, portion of the frame main body 2 in the same manner as 38, so that the side stay 3 is firmly fixed to the side end 40.

With the above configuration, in this modified embodiment 1, prior to plugging of the insertion portion 31 of the side stay 3 into the side end hollow portion of the frame main body 2, as shown in Figure 10, the movable second metal-made bar 40 is disposed at the side portion hollow portion of the frame main body 2, and the distal end portion of the fixing bolt 38 is screwed into the movable second metal-made bar 40.

Further, a recessed groove 52 having a shape (11a, 11b) by rivets 51 penetrating side faces thereof 50, the second metal-made bar 50 is fixed to the both side plates 11 (11a, 11b) by the fixing bolt 38, so as to penetrate the through-holes 12 and 21 formed coaxially from the upper plate 10a toward the first metal-made bar 20. At this time, the convex projection portion 36 of the vertical member 35a is fitted into the groove 22 of the first metal-made bar 20, and it functions to align the side stay insertion portion 31 and the horizontal member 35b of the L-shaped fixing member 35. Thereby, the insertion portion 31 of the side stay 3 is sandwiched between the metal-made bar 20 and the horizontal member 35b of the L-shaped fixing member 35. Thereby, the insertion portion 31 of the side stay 3 is firmly fixed to the frame main body 2.

In this embodiment, also, the third metal-made bar 40A similar to the second metal-made bar 40 is used as the movable fixing member, and prior to plugging of the insertion portion 31 of the side stay 3 into the side end hollow portion of the frame main body 2, as shown in Figure 10, the movable second metal-made bar 40 is used, but the second metal-made bar 40A in the modified embodiment 1-1 is different from the second metal-made bar 40 regarding such a point that a projection portion 40A1 extending in a longitudinal direction (namely, the longitudinal direction of the frame main body 2) is formed on a lower face of the second metal-made bar 40A.

In the modified embodiment 1-1, also, a second metal-made bar 40A similar to the second metal-made bar 40 in the embodiment 1 is used, but the second metal-made bar 40A in the modified embodiment 1-1 is different from the second metal-made bar 40 regarding such a point that a projection portion 40A1 extending in a longitudinal direction (namely, the longitudinal direction of the frame main body 2) is formed on a lower face of the second metal-made bar 40A.

In the modified embodiment 1-1, also, a second metal-made bar 40A similar to the second metal-made bar 40 in the embodiment 1 is used, but the second metal-made bar 40A in the modified embodiment 1-1 is different from the second metal-made bar 40 regarding such a point that a projection portion 40A1 extending in a longitudinal direction (namely, the longitudinal direction of the frame main body 2) is formed on a lower face of the second metal-made bar 40A.

Further, in the modified embodiment 1-1, a fixed third metal-made bar 50 is disposed to be positioned below the movable metal-made bar 40A. The third metal-made bar 50 is fixed to the both side plates 11 (11a, 11b) by rivets 51 penetrating side faces thereof from the both side plates.

Further, a recessed groove 52 having a shape fitted on the projection portion 40A1 formed on the lower face of the above second metal-made bar 40A is formed on an upper face of the third metal-made plate 50 along a longitudinal direction (namely, the longitudinal direction of the frame main body 2).

With the above configuration, in this modified embodiment 1-1, also, the insertion portion 31 of the side stay 3 is sandwiched between the first metal-made bar 20 and the second metal-made bar 40A by the fixing bolt 38, so that the side stay 3 is firmly fixed to the side end portion of the frame main body 2 in the same manner as described in the above embodiment 1.

Furthermore, in the modified embodiment 1-1, the lower face projection portion 40A1 of the second metal-made bar 40A is fitted on the recessed groove 52 formed on the upper face of the third metal-made bar 50 fixed to the frame main body 2, and with this configuration, horizontal oscillation of the side stay 3 can be suppressed.

Next, another embodiment of a side stay attaching part structure 60 according to the present invention will be described with reference to Figure 12.

In this embodiment, also, as shown in Figure 12, first, the side stay fixing bolt 38 is screwed into the screw hole 37 of the L-shaped fixing member 35 so as to penetrate the through-holes 12 and 21 formed coaxially from the upper plate 10a toward the first metal-made bar 20. At this time, the convex projection portion 36 of the vertical member 35a is fitted into the groove 22 of the first metal-made bar 20, and it functions to align the side stay insertion portion 31 and the horizontal member 35b of the L-shaped fixing member 35. Thereby, the insertion portion 31 of the side stay 3 is sandwiched between the metal-made bar 20 and the horizontal member 35b of the L-shaped fixing member 35 by the fixing bolt 38, so that the side stay 3 is firmly fixed to the frame main body 2.

In this embodiment, also, the third metal-made bar 50 is disposed so as to be positioned below the horizontal member 35b as still another modified embodiment 2-1, as shown in Figure 13.

That is, in the modified embodiment 2-1, also, an L-shaped fixing member 35A similar to the L-shaped fixing member 35 in the above embodiment 2 is used, but the L-shaped fixing member 35A is different from the L-shaped fixing member 35 regarding such a point that a projection portion 35B1 is formed on a lower face of the horizontal member 35b in the modified embodiment 2-1 so as to extend in a longitudinal direction (namely, in the longitudinal direction of the frame main body 2). The whole configuration and function of the L-shaped fixing member 35A is similar to those of the L-shaped fixing member 35 in the above embodiment 2.

In the modified embodiment 2-1, as described
above, the fixed third metal-made bar 50 is disposed so as to be positioned below the horizontal member 35b. The third metal-made bar 50 is fixed to the both side plates 11 (11a, 11b) by rivets 51 penetrating the side faces thereof from the both side plates.

[0084] Further, a recessed groove 52 having a shape fitted on the projection portion 35b1 formed on the lower face portion of the horizontal member 35b is formed on an upper face of the third metal-made bar 50 along a longitudinal direction (namely, in the longitudinal direction of the frame main body 2).

[0085] With the above configuration, in the modified embodiment 2-1, also, the insertion portion 31 of the side stay 3 is sandwiched between the first metal-made body 20 and the L-shaped fixing member 35A by the fixing bolt 38, so that side stay 3 is firmly fixed to the side end portion of the frame main body 2 in the same manner as described in the above embodiment 2.

[0086] Further, in the modified embodiment 2-1, the lower face projection portion 35b1 of the horizontal member 35b of the L-shaped fixing member 35A is fitted into the recessed groove 52 formed on an upper face of the third metal-made bar 50 fixed to the frame main body 2, and with this configuration, horizontal oscillation of the side stay 3 can be suppressed.

Embodiment 3

[0087] Figure 14 shows another embodiment of the side stay attaching part structure 60. In the above embodiment 1, as shown in Figure 10, the second metal-made bar 40 is used as the movable fixing member.

[0088] In this embodiment 3, a fixed second metal-made bar 42 is used instead of the movable second metal-made bar 40. The configurations of the first metal-made bar 20 and the side stay 3 in the embodiment 1 are the same as described in the embodiment 1.

[0089] However, in this embodiment, the second fixed metal-made bar 42 is fixed to the both side plates 11 (11a, 11b) by rivets 44 penetrating side faces of the second fixed metal-made bar 42 from the sides of the both side plates. The remaining configuration of the second fixed metal-made bar 42 is similar to that of the second metal-made bar 40 in the embodiment 1.

[0090] According to this embodiment, slits 45 extending from the side end face of the frame main body 2 by a predetermined length are formed in the both side plates 11 (11a, 11b) of the frame main body 2 to be positioned between the first metal-made bar 20 and the second metal-made bar 42. The length L45 of the slit 45 is preferably set longer than the lengths of the upper face and lower face fixing metal-bars 20 and 42 in the longitudinal direction by a length of 2 to 3 cm or more, and the width W45 of the slit 45 is set to about 1 to 2 mm.

[0091] With the above configuration, in this modified embodiment, the insertion portion 31 of the side stay 3 is plugged into the side face hollow portion between the first fixed metal-made bar 20 and the second fixed metal-made bar 42 of the frame main body 2. Thereby, the upper face convex projection 33 of the insertion portion 31 of the side stay 3 is fitted into the groove 22 of the metal-bar 20 and the side stay 3 is integrally attached to the side face of the frame main body 2. A lower face of the side stay insertion portion 31 is caused to abut on the upper face of the second fixed metal-made bar 42.

[0092] Next, as shown in Figure 14, the side stay fixing bolt 38 is screwed into the screw hole 43 of the second fixed metal-made bar 42 so as to penetrate the through-holes 12 and 21 from the upper plate 10a toward the metal-made bar 20 and further penetrate the U-shaped groove 32 of the side stay insertion portion 31. Thereby, the insertion portion 31 of the side stay 3 is sandwiched between the first metal-made bar 20 and the second metal-made bar 42 by the fixing bolt 38, and the side stay 3 is fixed to the frame main body 2 by screwing the fixing bolt 38 to the fixed metal-made 42 to fasten the fixing bolt 38. Of course, as explained in each of the above embodiments, attaching may be performed such that the side stay fixing bolt 38 is first inserted from the upper plate 10a toward the metal-made bar 20 to penetrate the through-holes 12 and 21 and is further screwed into the screw hole 43 of the second metal-made bar 42, and the side stay insertion portion 31 is then inserted such that the U-shaped groove 32 of the side stay insertion portion 31 is fitted to the screw shaft of the fixing bolt 38.

[0093] In any case, when the side stay insertion portion 31 is sandwiched between the first metal-made bar 21 and the second metal-made bar 42 and the fixing bolt 38 is screwed and fastened to the fixed metal-made bar 42, since the slits 45 are formed in the both side plates 11 (11a, 11b), the both side plates 11 (11a, 11b) can be deformed slightly in the vertical direction. Thereby, the side stay insertion portion 31 is firmly fixed to the frame main body side portion.

Embodiment 4

[0094] Figure 15 shows another embodiment of the side stay attaching part structure 60. In the embodiment 1, as shown in Figure 10, the insertion portion 31 of the side stay 3 is sandwiched between the first metal-made bar 20 and the second metal-made bar 40 by the fixing bolt 38, and the side stay 3 is firmly fixed to the side end portion of the frame main body 2.

[0095] In this embodiment 4, as shown in Figure 15, a moving metal-made bar for adjustment 20B is disposed so as to be positioned below a first metal-made bar 20A constituted in the same manner as the first metal-made bar 20 in the embodiment 1. That is, the first metal-made bar 20A is fixedly attached to the upper plate 10a by adhesive agent, but the moving metal-made bar for adjustment 20B is fixed to the upper plate 10a and the first metal-made bar 20A by a fixing bolt 55. In this embodiment, the recessed groove 22 is not formed on a lower face of the first metal-made bar 20A, but a recessed groove 22 engaged with the upper face convex projection.
Embodiment 5

[0101] Figure 17 shows another embodiment of the side stay attaching part structure 60. The embodiment 5 is a modified embodiment of the above embodiment 4 shown in Figure 15.

[0102] In this embodiment 5, also, a second metal-made bar 40A similar to the second metal-made bar 40 in the embodiment 4 is used, but the second metal-made bar 40A in the embodiment 5 is different from the second metal-made bar 40 in the embodiment 4 regarding such a point that a projection portion 40A1 is formed on a lower face portion of the second metal-made bar 40A so as to extend in a longitudinal direction (namely, in the longitudinal direction of the frame main body 2). The whole configuration and function of the second metal-made bar 40A are similar to those of the second metal-made bar 40 of the embodiment 4.

[0103] Further, in this embodiment 5, a fixed third metal-made bar 50 is provided so as to be positioned below the movable metal-made bar 40A. The third metal-made bar 50 is fixed to the both side plates 11 (11a, 11b) by rivets 51 penetrating both faces thereof from the both side plates.

[0104] Further, a recessed groove 52 having a shape fitted on the projection portion 40A1 formed on the lower face of the above second metal-made bar 40A is formed on an upper face of the third metal-made bar 50 along a longitudinal direction (namely, in the longitudinal direction of the frame main body 2).

[0105] With the above configuration, in the embodiment 5, also, the insertion portion 31 of the side stay 3 is sandwiched between the first metal-made bar 20A and the second metal-made bar 40A by the fixing bolt 38 so that the side stay 3 is firmly fixed to the side end portion of the frame main body in the same manner as described in the embodiment 4.

[0106] Further, in the embodiment 5, the lower face projection portion 40A1 of the second metal-made bar 40A is fitted into the recessed groove 52 formed on the upper face of the third metal-made bar 50 fixed to the frame main body 2, and with this configuration, horizontal oscillation of the side stay 3 can be suppressed.

Embodiment 6

[0107] Figure 18 shows another embodiment of the side stay attaching part structure 60. The embodiment 6 is a modified embodiment of the embodiment 4 shown in Figure 15.

[0108] In the embodiment 6, as shown in Figure 18, an L-shaped fixing member 35 is used as the second metal-made bar instead of the above movable metal-made bar 40 in the embodiment 4.

[0109] The L-shaped fixing member 35 of the embodiment 6 has a configuration similar to the L-shaped fixing member 35 in the embodiment 2 explained with reference to Figure 12.

[0110] That is, the L-shaped fixing member 35 is composed of a vertical member 35a and a horizontal member 35b, and a convex projection 36 with a predetermined length fitted into the groove 22 of the metal-made bar 20 is formed on an upper face of the vertical member 35a.
The horizontal member 35b is formed with a screw hole 37 screwed to the side stay fixing bolt 38 in the vertical direction. The horizontal member 35b functions as a nut member for the fixing bolt 38. The configuration of the side stay 3 is the same as described in the embodiment 1.

In this embodiment, also, as shown in Figure 18, the side stay fixing bolt 38 is first screwed into the screw hole 37 of the horizontal member 35b of the L-shaped fixing member 35 so as to penetrate the through-holes 12 and 21 formed coaxially from the upper plate 10a toward the first metal-made bar 20A. At this time, the convex projection portion 36 of the vertical member 35a is fitted into the groove 22 of the moving metal-made bar for adjustment 20B, and it functions to align the side stay insertion portion 31 and the horizontal member 35b of the L-shaped fixing member 35 with each other. Thereby, the insertion portion 31 of the side stay 3 is sandwiched between the first metal-made bar 20A (the moving metal-made bar for adjustment 20B) and the horizontal member 35b of the L-shaped fixing member 35 by the fixing bolt 38, so that the side stay 3 is firmly fixed to the frame main body 2.

As shown in Figure 19, in this embodiment, also, like the above modified embodiment 4-1, an opening portion 59 having an elongated oval shape can further be formed in the both side plates 11 (11a, 11b) of the frame main body 2, or in one side plate 11 in a region corresponding to the position of the first metal-made bar 20A by machining as a modified embodiment 6-1. With this configuration, attaching of the first metal-made bar 20A, installation of a shim, or the like can be performed simply with excellent workability, and working efficiency of assembling can be improved.

According to the embodiment 6 and the modified embodiment 6-1, attaching accuracy between the side stay 3 and the frame main body 2 can be improved with a simpler structure.

Embodiment 7

Figure 20 shows another embodiment of the side stay attaching part structure 60. The embodiment 7 is a modified embodiment of the above embodiment 6 shown in Figure 18.

In the embodiment 7, as shown in Figure 20, a third metal-made bar 50 can be provided so as to be positioned below the horizontal member 35b.

That is, in the embodiment 7, also, a L-shaped fixing member 35A similar to the L-shaped fixing member 35 in the above embodiment 6 is used, but a horizontal member 35b in the embodiment 7 is different from the horizontal member 35 in the embodiment 6 regarding in such a point that a projection portion 35b1 is formed on a lower face of the horizontal member 35b so as to extend in a longitudinal direction (namely, the longitudinal direction of the frame main body 2). The whole configuration and function of the L-shaped fixing member 35A are similar to those of the L-shaped fixing member 35 in the embodiment 6.

In the embodiment 7, a fixed third metal-made bar 50 is provided to be positioned below the horizontal member 35b. The third metal-made bar 50 is fixed to the both side plates 11 (11a, 11b) by rivets 51 penetrating side faces thereof from the both side plates.

Further, a recessed groove 52 having a shape fitted on the projection portion 35b1 formed on the lower face portion of the horizontal member 35b is formed on an upper face of the third metal made bar 50 along a longitudinal direction (namely, the longitudinal direction of the frame main body 2).

Further, in the embodiment 7, also, the insertion portion 31 of the side stay 3 is sandwiched between the moving metal-made bar for adjustment 20B and the horizontal member 35b of the L-shaped fixing member 35A by the fixing bolt 38, so that the side stay 3 is firmly fixed to the side end portion of the frame main body 2 in the same manner as described in the embodiment 6.

Further, in the embodiment 7, the lower face projection portion 35b1 of the L-shaped fixing member 35A is fitted in the recessed groove 52 formed on an upper face of the third metal made bar 50 fixed to the frame main body 2, and with this configuration, horizontal oscillation of the side stay 3 can be suppressed.

In the embodiment 7, also, as described with reference to Figure 19, an opening portion 59 having an elongated oval shape can further be formed in the both side plates 11 (11a, 11b) of the frame main body 2, or in one side plate 11 in a region corresponding to the position of the first metal-made bar 20A by machining like the modified embodiment 6-1 of the embodiment 6.

In each of the above embodiments, though the heald frame stave made of carbon fiber reinforced composite material and the side stay attaching part structure according to the present invention have been described in detail, next, features obtained when the heald frame stave 2 made of carbon fiber reinforced composite material of this invention having the above configuration is used in a heald frame of a loom will be described collectively.

As described above, in the heald frame of a loom, it is demanded to achieve speed-up and vibration-isolating property of a loom by making a heald frame stave of carbon fiber reinforced composite material to achieve weight reduction and increase in rigidity. Of course, it is essential to achieve response to elongation and quality improvement.

Therefore:

(1) In a heald frame 1 (see Figure 1) constituted by coupling upper and lower heald frame staves (frame main bodies) 2 by using side frames 3, how to reduce vertical deflection constitutes a designing important point. Therefore, it is considered to use carbon fiber reinforced composite material with high elasticity concentrically at both end edge portions of each heald frame stave 2 in the vertical direction.
[0125] Considering this point, in this invention, a structure where lateral ribs 10 (10a, 10b) made of CFRP (unidirectional carbon fiber reinforced composite material) having a UD shape and produced by directing long fibers in longitudinal directions thereof in a pulling manner are arranged at both end edge portions in a vertical direction of the hollow structure portion 2A of the heald frame stave 2 formed in a hollow structure is adopted.

[0126] That is, with this structure, the present invention has a structure where a vertical sectional rigidity of the heald frame stave 2 determining vertical deflection can be obtained maximally with less material.

(2) In the heald frame stave 2, a heald or yarns to be weaved are hung from a lower end thereof and load is applied to the lower end. A point receiving the load becomes important. In order to minimize the vertical deflection, it is necessary to set the point receiving the load at a portion where the sectional rigidity of the heald frame stave 2 can be exerted fully.

[0127] Therefore, it is optimal to cause the upper plate 10a serving as the lateral rib of the carbon fiber reinforced composite material extending in the longitudinal direction and positioned at the uppermost portion of the heald frame stave 2 to support these loads.

[0128] In view of these circumstances, in the present invention, such a structure is adopted that the metal-made bar 20 for transmitting a load to the side stay 3 directly is integrally attached to the upper plate 10a serving as the lateral rib by adhesive agent or the like, so that the sectional rigidity of the heald frame stave 2 can be exerted fully.

(3) Next, as a function required in the heald frame, there is accuracy of fixing the side stay 3.

[0129] The side stay 3 serves to assemble the upper and lower heald frame staves 2 with a constant distance to keep accuracy of the assembling. If not, such a problem occurs that a width of the portion to be attached with the heald varies, so that it becomes impossible to attach the heald or the heald is broken during weaving in a loom.

[0130] A factor for determining the accuracy is the metal-made bars 20 caused to adhere to the upper portion of the heald frame stave 2.

[0131] It is essential that attaching of the side stay 3 is performed with a predetermined accuracy and the accuracy does not fluctuate during serving. If a face for attachment of the side stay 3 is formed of carbon fiber reinforced composite material, the face fluctuates due to wearing, scratching, or the like for a long-term use because the face is constituted as a resin face, which results in occurrence of a drawback. Therefore, it is essential that the face for fixing the side stay 3 is a hard metal face which is hardly worn.

[0132] Securing of the accuracy at an attaching time of the metal-made bar 20 is achieved by performing adhesion at an adhering time sufficiently carefully, or by adopting a configuration where, for example, even if accuracy is poor, the problem of the poor accuracy is handled by working performed later.

[0133] Incidentally, the accuracy at the attaching time of the side stay 3 should be a distance for attaching the heald at the attaching time of the side stay 3, which is ±0.1 mm.

(4) Next, a function required in the heald frame 1 is strength, and it is important the heald frame 1 is not broken by a fastening force with the fixing bolt 38 for attaching the side stay 3 or a load acting on the heald in operation or a load from weaving yarns.

[0134] Both the loads act on the metal-made bar for fixation 20 caused to adhere to the lateral rib (upper plate) 10a made of carbon fiber reinforced composite material and extending in the longitudinal direction of the upper portion of the heald frame stave 2 attached with the side stay 3.

[0135] First, when attaching of the side stay 3 is performed using the fixing bolt 38, the fixing member (insertion portion 31) of the side stay 3 is sandwiched between the upper first metal-made bar 20 and the lower second metal-made bar 35, 40, or 42 and these members are tightened by the bolt 38. At this time, a reaction force of the bolt 38 is received by the upper face (a lower face of the bolt head) of the carbon fiber reinforced composite material lateral rib (the upper plate) 10a positioned on the upper portion of the side stay stave. Thereby, a compression force identical to the fastening force with the bolt 38 act between the upper face of the carbon fiber reinforced composite material lateral rib (the upper plate) 10a and the first metal-made bar 20 caused to adhere to the lower face of the lateral rib 10a.

[0136] Since the compression force is received by the solid carbon fiber reinforced composite material lateral rib (upper plate) 10a and the first metal-made bar 20, an unbreakable structure is obtained. On the other hand, if the compression force is configured to be received by the side plates 11 (11a, 11b) made of a carbon fiber reinforced composite material and positioned on the side faces, the carbon fiber reinforced composite material is deformed or broken, so that sufficient force cannot be sustained.

[0137] Of course, for safety, it is useful to arrange a metal-made washer just below the head of the fixing bolt 38 to protect the carbon fiber reinforced composite material lateral rib (the upper plate) 10a positioned on the side of the lower face of the fixing bolt 38.

[0138] Next, as a force at a weaving time in a loom, a force for moving the heald frame vertically is inputted from the side stay fixing member (insertion portion 31) to the first metal-made bar 20 on the upper face side. The force is a force for lifting up the heald attached to the heald frame stave 2, the tensions of weaving yarns or the like, and it is not so large.

[0139] The force is inputted into the carbon fiber reinforced composite material lateral rib (the upper plate) 10a extending in a lateral direction of the upper face of the heald frame stave 2 to be transmitted to the whole stave through the carbon fiber-reinforced composite material side plates 11 (11a, 11b) of the stave side face caused
In order to resist this force, adhesion force between the carbon fiber reinforced composite material lateral rib (the upper plate) 10a extending in a lateral direction of the upper face of the heald frame stave and the side plates 11 (11a, 11b) made of the carbon fiber reinforced composite material positioned on the side face of the stave becomes essential. Therefore, in order to secure an adhesion area, it is necessary to set the thickness H2 of the lateral rib (lower plate) 11b as well as the thickness H1 of the carbon fiber reinforced composite material lateral rib (the upper plate) 11a to 5 mm or more.

As shown in Figure 8, fixing the first metal-made bar 20 on the upper face side by using the rivets 22 is for safety measures for preventing releasing of the adhesion for any reason.

(5) Next, a function required in the heald frame 1 is to secure a weaving speed.

(6) Of course, quietness is also required in the heald frame. In particular, recently, a demand of a heald frame stave. In particular, recently, a demand of a 

The tensile elasticity and the density of a material to be used are important points to the primary natural frequency.

Here, when it is assumed that the tensile elasticity and the density of aluminum are 70 GPa and 2.7g/cm³, while the average tensile elasticity and the density of used CFRP are 107 GPa and 1.6g/cm³, and both the materials have the same length, since the primary natural frequency is proportional to the root (the one-half power) of the tensile elasticity and inversely proportional to the root (the one-half power) of the density, the primary natural frequency of the heald frame stave 2 of this invention becomes 1.6 times that of the aluminum-made heald frame stave, from which it is found that the primary natural frequency of the heald frame stave 2 of this invention becomes not problematic.

(6) Of course, quietness is also required in the heald frame. In particular, recently, a demand of a heald frame with high quietness becomes higher in view of environmental issues in Europe.

On the other hand, since the heald frame stave made of CPRF is a composite material with resin, it is a product having high quietness because the frame itself is low in resonating property.

In order to increase the effect of the quietness, it is possible to further increase the effect by inserting foamed material of urethane, honeycomb of paper or the like in the hollow portion of the heald frame stave made of CFRP except for end portions thereof attached with the side stay.

Claims

1. A heald frame stave made of carbon fiber reinforced composite material and having a hollow structure which is formed in an elongated shape, extends in a longitudinal direction thereof, and is attached with side stays at both end portions thereof in the longitudinal direction, comprising:

   - both side plates formed in a rectangular shape and made of carbon fiber reinforced composite material, and extending in the longitudinal direction;
   - an upper plate and a lower plate made of carbon fiber reinforced composite material and coupling, along the longitudinal direction, upper ends of the both side plates with each other and lower ends thereof with each other; and
   - first metal-made bars for attachment of the side stays, which are integrally attached on a lower
face of the upper plate at both end portions of the upper plate in the longitudinal direction, wherein the upper plate and the lower plate are made of unidirectional carbon fiber reinforced composite material produced by directing carbon fibers in a pulling fashion in the longitudinal direction, and thicknesses thereof in a vertical direction perpendicular to the longitudinal direction are in a range of 5 mm or more to 20 mm or less.

2. The heald frame stave of a hollow structure made of carbon fiber reinforced composite material according to claim 1, wherein a reinforcing plate is provided on a lower face of the upper plate between the two first metal-made bars attached at the both end portions of the upper plate in the longitudinal direction, respectively, and the reinforcing plate is made of unidirectional carbon fiber reinforced composite material produced by directing carbon fibers in a pulling fashion in the longitudinal direction, and a thickness thereof in a vertical direction perpendicular to the longitudinal direction is in a range of 5 mm or more to 20 mm or less.

3. The heald frame stave made of carbon fiber reinforced composite material and having a hollow structure according to claim 1 or 2, wherein the first metal-made bars and the both side plates are coupled to each other by metal-made rivets.

4. A side stay attaching part structure for attaching the heald frame stave made of carbon fiber reinforced composite material and having a hollow structure according to any one of claims 1 to 3 to the side stay, wherein the side stay is provided with a side stay main body extending in a vertical direction, and a side stay insertion portion projecting from the side stay main body toward the heald frame stave to be capable of being inserted into the heald frame stave of the hollow structure, a fixing bolt is inserted from the upper plate so as to penetrate the upper plate, the first metal-made bar, and the side stay insertion portion, and a second metal-made bar having a screw hole is screwed to a lower end of the fixing bolt, and the side stay insertion portion which has been inserted into the heald frame stave is fixed to the heald frame stave by the fixing bolt and the second metal-made bar.

5. The side stay attaching part structure according to claim 4, wherein the side stay insertion portion is formed with a convex projection on an upper face thereof, a recessed groove engaged with the convex projection of the side stay insertion portion when the side stay insertion portion has been inserted into the heald frame stave is formed on an lower face of the first metal-made bar contacting with an upper face of the side stay insertion portion.

6. The side stay attaching part structure according to claim 4 or 5, wherein a third metal-made bar is provided so as to be positioned below the second metal-made bar, the third metal-made bar is connected to the both side plates by metal-made rivets, and the second metal-made bar is formed with a convex projection on a lower face thereof, a recessed groove is formed on an upper face of the third metal-made bar opposed to a lower face of the second metal-made bar, and the convex projection of the second metal-made bar is fitted into the recessed groove of the third metal-made bar when the side stay has been attached to the heald frame stave.

7. The side stay attaching part structure according to any one of claims 4 to 6, wherein the second metal-made bar is an L-shaped fixing member having a horizontal member having the screw hole screwed to the fixing bolt and a vertical member extending in a vertical direction to the horizontal member.

8. The side stay attaching part structure according to claim 7, wherein a projection fitted into a groove formed on a lower face of the first metal-made bar is formed on an upper face of the vertical member of the L-shaped fixing member.

9. The side stay attaching part structure according to claim 4 or 5, wherein the second metal-made bar is joined to the both side plates by metal-made rivets, the both side plates have slits formed so as to extend from the respective side ends of the both side plates in the longitudinal direction by a predetermined length and positioned between the first metal-made bar and the second metal-made bar.

10. The side stay attaching part structure according to claim 4, wherein a moving metal-made bar for adjustment is disposed so as to be positioned below the first metal-made bar and is fixed to the upper plate and the first metal-made bar by a fixing bolt, the side stay insertion portion is inserted between the moving metal-made bar for adjustment and the second metal-made bar, and the fixing bolt is inserted from the upper plate so as to penetrate the upper plate, the first metal-made bar, the moving metal-made bar for adjustment, and...
the side stay insertion portion, and is screwed into the second metal-made bar having a screw hole and disposed at a lower end of the fixing bolt.

11. The side stay attaching part structure according to claim 10, wherein
the side stay insertion portion is formed with a convex projection on an upper face thereof, and
a recessed groove engaged with the convex projection of the side stay insertion portion when the side stay insertion portion has been inserted into the heald frame stave is formed on a lower face of the moving metal-made bar for adjustment contacting with an upper face of the side stay insertion portion.

12. The side stay attaching part structure according to claim 10 or 11, wherein
a third metal-made bar is provided so as to be positioned below the second metal-made bar,
the third metal-made bar is joined to the both side plates by metal-made rivets, and
the second metal-made bar is formed with a convex projection on a lower face thereof, a recessed groove is formed on an upper face of the third metal-made bar opposed to a lower face of the second metal-made bar, and the convex projection of the second metal-made bar is fitted into the recessed groove of the third metal-made bar when the side stay has been attached to the heald frame stave.

13. The side stay attaching part structure according to any one of claims 10 to 12, wherein
the second metal-made bar is an L-shaped fixing member having a horizontal member having the screw hole screwed to the fixing bolt and a vertical member extending in a vertical direction to the horizontal member.

14. The side stay attaching part structure according to claim 13, wherein
a projection fitted into a groove formed on a lower face of the moving metal-made bar for adjustment is formed on an upper face of the vertical member of the L-shaped fixing member.

15. The side stay attaching part structure according to any one of claims 10 to 14, wherein
an opening portion is formed on at least one side plate in a region corresponding to the position of the first metal-made bar.

16. The side stay attaching part structure according to any one of claims 4 to 15, wherein
the side stay insertion portion is a plate-shaped member having a thickness fitted into the hollow portion of the heald frame stave and formed in an approximately rectangular shape, and is formed with a U-shaped groove opened at a distal end portion of

the side stay insertion portion positioned on the opposite side of the side stay main body and extending from the distal end portion toward the side stay main body in a vertical direction by a predetermined length, the side stay insertion portion is inserted into the heald frame stave such that the U-shaped groove of the side stay insertion portion is fitted into the fixing bolt inserted from the side of the upper plate, and the side frame inserted into the heald frame stave is fixed by the fixing bolt and the second metal-made bar.
FIG. 2
**INTERNATIONAL SEARCH REPORT**

A. CLASSIFICATION OF SUBJECT MATTER

D03C9/06(2006.01)1

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)

D03C9/06

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


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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

<table>
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<tr>
<th>Category</th>
<th>Citation of document, with indication, where appropriate, of the relevant passages</th>
<th>Relevant to claim No.</th>
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<tr>
<td>Y</td>
<td>Microfilm of the specification and drawings annexed to the request of Japanese Utility Model Application No. 042248/1975 (Laid-open No. 124155/1976) (Toray Industries, Inc.), 07 October 1976 (07 10 1976), entire text; fig. 1, 2 (Family: none)</td>
<td>1-16</td>
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[X] Further documents are listed in the continuation of Box C.  
[ ] See patent family annex.

- Special categories of cited documents:
  - "A" document defining the general state of the art which is not considered to be of particular relevance
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Date of the actual completion of the international search 01 March, 2012 (01 03 12)

Date of mailing of the international search report 13 March, 2012 (13 03 12)

Name and mailing address of the ISA/ Japanese Patent Office

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<tr>
<td>A</td>
<td>JP 2008-127690 A (Nippon Steel Composite Co., Ltd.), 05 June 2008 (05.06.2008), entire text; all drawings (Family: none)</td>
<td>1-16</td>
</tr>
</tbody>
</table>
REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- JP H08269836 B [0018]