Title: SUPPORT SYSTEM FOR A SINGLE- OR MULTI-PIECE HOLLOW OBJECT

Abstract: A support system for a single- or multi-piece hollow object is provided. The support system generally includes an insert and a hardening system, used in combination to repair the hollow object. A method of repairing the hollow object using the support system is also provided.
SUPPORT SYSTEM FOR A SINGLE- OR MULTI-PIECE HOLLOW OBJECT

BACKGROUND OF THE INVENTION

[0001] The present invention relates to a support system for single- or multi-piece hollow objects. Such hollow objects include hockey sticks, golf clubs, sailboard and sailboat masts and booms, and ski poles.

[0002] Objects made or formed from hollow support pieces and/or objects that are hollow by design typically do not provide similar strength and support as compared to the same objects which are made of the same materials, but are solid in design and not hollow. However, hollow formed objects offer many advantages over solid formed objects including, but not limited to, hollow formed objects typically use less overall material and therefore are lighter in weight, more maneuverable and easier to transport. Additionally, because less material is used in the construction of hollow objects, these hollow objects typically cost less money to produce.

[0003] While objects that are hollow offer the above advantages, these hollow objects, when in use, may undergo sudden impact or extreme flexural stress, and may also undergo structural stress with use over time. Therefore, these hollow objects may develop fissures, develop cracks and/or fracture into multiple pieces. Once the hollow object is cracked or fractured, replacing the cracked section of the object, or completely replacing the fractured section of an object may either be very costly, or in many cases, not possible. In order to obtain a hollow object that is comparable in support and strength to the original uncracked or unfractured hollow object, a user is left with either purchasing, if possible and if available, a new hollow piece to replace the cracked or fractured piece of the object, or the user must replace the entire object all together. Both of these options are very costly and may take significant amounts of time.

[0004] Therefore, there is a need for an easy to use, cost-efficient support system for a single- or multiple-piece hollow objects that may be utilized where either more support is desired, or in a fractured yet unitary hollow object, and/or in a once-unitary but now multi-piece object.

SUMMARY OF THE INVENTION

[0005] One aspect of the present invention is a hollow object repair kit including an insert. The insert is typically comprised of at least one inner section and at least one layer of material at least partially covering the center section. Also included in the hollow object repair kit is a liquid hardening system.
Another aspect of the present invention is a bracket system that may be utilized with the support system for a single- or multi-piece object of the present invention. Such a bracket system includes one or more faces capable of generally immobilizing a single- or multi-piece object while the liquid hardening system cures, dries, or hardens.

Yet another aspect of the present invention is a method of repairing a hollow object, including the steps of: (a) providing a first hollow piece of an object and a second hollow piece of an object; (b) providing an insert, at least a portion of which is a material external of a center section; (c) positioning the insert into the first hollow piece; (d) positioning the insert into the second hollow piece; and (e) inserting a liquid hardening system in one of the hollow pieces to contact the insert.

These and other features, advantages, and objects of the present invention will be further understood and appreciated by those skilled in the art by reference to the following specification, claims, and appended drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a perspective view of an insert of the present invention;

Figs. 2A-F are cross-sectional plan views of various inserts of the present invention;

Fig. 3 is a perspective view of a grooving bit of the present invention;

Fig. 4 is an elevational view of a bracket system of the present invention;

Fig. 5 is a perspective view of an insertion tool for use in the method of the present invention;

Fig. 6 is a perspective view of an alignment guide for use in the method of the present invention;

Fig. 7 is a perspective view of a broken hockey stick in the bracket system of the present invention;

Fig. 8 is a perspective view of a hockey stick in the bracket system of the present invention, with a liquid hardening system being poured into the stick; and

Fig. 9 is a cut-away elevational view of a fixed hollow object.

DETAILED DESCRIPTION OF PREFERRED EMBODIMENT

For purposes of description herein, the terms “upper,” “lower,” “right,” “left,” “rear,” “front,” “vertical,” “horizontal,” and derivatives thereof shall relate to the invention as oriented in Fig. 4. However, it is to be understood that the invention may assume various alternative orientations, except where expressly specified to the contrary. It is also to be understood that the specific devices and processes illustrated in the attached
drawings and/or photographs and described in the following specification are exemplary embodiments of the inventive concepts defined in the appended claims. Hence, specific dimensions and other physical characteristics relating to the embodiments disclosed herein are not to be considered as limiting, unless the claims expressly state otherwise. The term "hollow" as used herein includes objects that are tubular by design or objects which include at least pieces and or parts which are hollow or tubular by design. The term "hollow" is not meant to be limited by any shape of the given object, but instead refers to an object having an unfilled space within. However, the present invention could also be used on products which are not entirely tubular, or are not completely enclosed on one side.

[0019] The preferred embodiment of the invention includes a support system for generally hollow objects. Such a support system for a single- or multi-piece hollow object may be utilized in any hollow object including, but not limited to: hockey sticks; furniture or furniture pieces; support poles for sailboards and sailboats, golf clubs, ski poles, fishing poles, support structures and the like, or any derivations and/or combinations of any of the above.

[0020] Referring to Fig. 1, insert 20 of the preferred embodiment includes a porous substance, such as a foam, or otherwise solid center section 10 and a fabric 15 covering at least a portion of the center section 10. The foam center section 10 may be any type of open-cell or closed-cell foam, depending upon the porosity desired. The foam is at least partially surrounded by at least one layer of a fabric or cloth 15. This configuration of at least one center section 10 surrounded by at least one layer of fabric or cloth 15 is hereinafter referred to as insert 20. Fabric 15 of insert 20 may be secured at two opposing ends (top end and bottom end) of insert 20. Securing devices (not shown) can be used to prevent the unraveling of the fabric. Such securing devices may include common hot melt adhesives, zip ties, rubber bands, tape, and the like. Preferably, however, a rubber cement is used to stabilize the ends of the fabric sleeving. Use of rubber cement also allows compression and decompression of insert 20.

[0021] Center section 10 is preferably porous enough to allow a liquid hardening system discussed below, such as an epoxy, to flow through it. Typically, open-cell foam is preferred over closed-cell foam due to the greater porosity provided by open-cell foams, although a closed-cell foam may be used with the present invention. As used herein, "open-cell" foams include what are sometimes referred to as "open pore" foams. This greater porosity allows liquid hardening systems to be absorbed into the pores within the
open-cell foam and to reach the fiber 15 quickly. This allows maximum time to wet out and saturate fabric 15 and the grooves in the side walls of the hollow object, as described below. A liquid hardening system absorbed into the cells of an open-cell foam typically provides a stronger center section as compared to an open-cell foam without a liquid hardening system absorbed therein. In open-cell foam, the cell walls, or surfaces of the cell bubbles, are broken and air fills these spaces in the material. Therefore, when a liquid hardening system is introduced to an open-cell foam, the liquid hardening system fills at least some of the broken or air-filled cell bubbles.

Alternatively, when a closed-cell foam is used as center section 10, the liquid hardening system essentially coats the closed-cell foam center section creating an internal chamber of closed-cell foam. In closed-cell foams, most of the cells or bubbles in the foam are not broken, and thereby the closed-cell foam may not absorb as much of a liquid hardening system like an open-cell foam. When utilized as center section 10, closed-cell foam typically has varying degrees of hardness, depending upon its density. Also, the use of closed-cell foams as center section 10 may also result in a lighter center section 10 because the closed-cell foams do not absorb as much of the liquid hardening system.

When either an open-cell or closed-cell foam is utilized in insert 20, the foam may be in a shape according its intended use. The shape preference of insert 20 depends on the shape of the space insert 20 is to be inserted into. The foam center section 10 enhances the ability of the insert 20 to be customized to any shape desired or required in use. The foam may be comprised of any material, including, but not limited to, polyvinyl chloride (PVC), polystyrene (PS), polyurethane (PU), polymethacrylamide, polyetherimide (PEI), styreneacrylonitrile (SAN), polyethylene (PE), man-made honeycomb, or any combinations or any derivations of any of the above. These foams may be crosslinked, uncrosslinked and/or laminated foams. Reticulated polyurethane foams are typically preferred. An example of such a reticulated polyurethane foam is FilterCrest™ T-20 “open pore” foam from Crest Foam Industries, Inc., of Moonachie, New Jersey.

Alternatively, insert 20 of the present invention may not contain a foam center section, but instead contain other materials as center section 10, including, but not limited to, wood, plastic, metal, or any derivations or combinations of any of the above. Section 10 may be made of any object which forces fabric 15 to the wall of the hollow object by rebound action or inflation, including but not limited to balloons, torsion arms, springs, and inflatable devices. When any of these materials are used as the center section of insert 20, these materials essentially become an internal chamber having a liquid-hardening-
system-coated fabric external layer. Also, when any of these materials are used as center section 10 of insert 20, these materials may be any shape according to the intended use of insert 20. Center section 10 may also be made of any of the materials above in combination with an open-cell or a closed-cell foam.

[0025] Insert 20 contains at least one layer of fabric or cloth 15 which at least partially covers center piece 10. The fabric or cloth 15 may include, but is not limited to, KEVLAR®, carbon fiber fabrics or materials, fiberglass, and/or any fabric capable of reinforcing a structure and/or enhancing performance of a structure when exposed to a liquid hardening system, however, two layers of a biaxially-weaved carbon fiber sleeve is preferred. The amount of the fabric used depends on the shape and size of center section 10. Also, the shape of the fabric 15 typically conforms to the shape of the center section 10 which the fabric at least partially surrounds.

[0026] A liquid hardening system is utilized in the present invention to harden center piece 10 and preferably fabric 15 surrounding center piece 10. A single component or multi-component liquid hardening system may be used in the present invention. Such a liquid hardening system may include, but is not limited to, a polyester resin system, an epoxy resin system, a urethane system, an acrylic system, hot melt adhesives, moisture cure epoxies, polymer systems, polyurea, polyurethane, bisphenol-A epoxy system, bisphenol-F epoxy system, a mercaptan-based epoxy system, a combination of a bisphenol-A and bisphenol-F system, or any other liquid hardening system or derivations and/or combinations of any liquid hardening system including, but not limited to those discussed above. Typically, a bisphenol-A epoxy system is preferred. When the liquid hardening system contacts center section 10 and the fabric 15 surrounding center section 10, fabric 15 may also be at least partially hardened thereby providing support for the hollow object to which the insert is incorporated within. A “liquid hardening system” includes systems that dry, cure, or harden for any reason, including but not limited to, evaporation or chemical reaction.

[0027] Insert 20 may take other configurations as well, depending on the size and shape of the hollow object and the desired stiffness or flexibility of the resultant shaft, and desired weight of the insert. Figs. 2A-2F show a cross-sectional top view of various configurations of insert 20. Although Figs. 2A-2F depict the hollow object as generally rectangular, the hollow object may be many shapes, including round or oval. Fig. 2A shows an embodiment of insert 20 with an outer layer of fabric 15, and an inner fabric layer 16. Inside the inner fabric layer 16 is a center section 10A, which is preferably an open-cell foam. The
embodiment of Fig. 2B has an outer layer of fabric 15 and two inner fabric layers 16B', 16B''. Within each of the two inner fabric layers 16B', 16B'' is a center section, denoted as 10B' and 10B'', respectively. In Fig. 2C, insert 20 has three center sections 10C', 10C'', and 10C''', and surrounded by a fabric layer, 16C', 16C'', and 16C''', respectively. Middle center section 10C' may be a less porous or non-porous foam, which provides structure, but helps reduce the weight of insert 20 because the liquid hardener will not penetrate, or will only penetrate minimally, middle center section 10C''. The insert 20 of Fig. 2D is very similar to that shown in Fig. 2B, but its center sections 10D' and 10D'' are wider than those of Fig. 2B. Fig. 2E shows an insert 20 with four center sections, 10E', 10E'', 10E''', and 10E'''''. Ultimately, the more center sections there are, the stiffer the insert, which may be preferred for certain hollow items. Fig. 2F shows another alternate design with a center section 10F, that is generally X-shaped and may be of extruded foam. Center section 10F may be porous or non-porous and coated or non-coated. This configuration allows for the liquid hardening system to flow more freely and quickly into the interior of the fabric layer 15.

[0028] A grooving bit 30 can be used in the repair of the hollow objects such as composite hockey stick shafts. Grooving bit 30 has at least one raised grooving area for creating "locking" grooves in the inside of the hollow object to add strength and durability to the repaired object. Grooving bit 30 preferably has at least three raised grooving areas (although it is not necessary to have that many) and as shown in Fig. 3, grooving bit 30 more preferably has at least four raised grooving areas 32, 34, 36, 38 on its outer diameter. It may have more or less raised grooving areas, depending on the desires of the user and the object being repaired. Grooving bit 30 preferably is sized and shaped to fit in a high speed rotary device, such as a DREMEL® ADVANTAGE™ high speed rotary saw Model 9000.

[0029] Another aspect of the present invention is a bracket system 40 (Fig. 4) that may be utilized in the repair of a single- or multi-piece object. Bracket system 40 is used for generally immobilizing a single- or multi-piece object while the liquid hardening system cures or dries. Bracket system 40 is in communication with at least one face of the single- or multi-piece object at least on each side of the fracture or break in the hollow object 60 (see Fig. 4). Bracket system 40 has a generally flat surface 52 and a receiving space 53, which is formed by sections 54 and 56, which are preferably at a 90° angle with respect to each other. The bracket system 40 preferably includes a clamp 42 so that a user may position the bracket system 40 on a work surface so that the hollow object may be worked
on at a more desired height. Clamp 42 is preferably adjustable vertically so it may be used at a comfortable position. This can be achieved by loosening knob 43, which allows adjustment of clamp 42. Bracket system 40 also preferably includes two tensioning devices 44, 46, each attached to surface 52, to apply an appropriate amount of tension to the single- or multi-piece hollow object to immobilize and/or position the single- or multi-piece hollow object. Tensioning devices 44, 46 generally include a soft, flexible bumper 48, 50 to contact the hollow object and immobilize it without damaging its structure. The use of flexible bumpers 48, 50 also allow the bracket system 40 to be used with different sized objects. The tensioning devices also preferably have a lock which holds the tensioning devices 44, 46 in a locked position. Bracket system 40 does not typically contact the face of the hollow object in or around the crack or fracture in the hollow object. This allows a user to apply tape, wax, or any other type of adhesive or sealant to the external surface of the hollow object. This is done around the break or fracture while the hollow object is immobilized, and is placed there to prevent leakage of liquid at the joint where the two shaft halves meet.

[0030] In another embodiment of the present invention, a kit is provided which includes insert 20, a plug/stopper 62, a liquid hardening system and optionally an adhesive tape and/or a wax based sealant for the shaft. The kit of the present invention may be utilized by the following steps as detailed below. A kit of the present invention may be utilized on any of the single- or multi-piece hollow objects as previously discussed in this application.

[0031] In operation, the support system of the present invention may be used to repair a hollow stick. A hockey stick having a fracture therein, or a hockey stick which has been completely broken into more than one piece, may be repaired by utilizing the support system of the present invention. In utilizing the support system of the present invention, the following steps may be performed (provided the hockey stick is in more than one piece):

[0032] 1. Make any stick surface repairs desired and remove the cap (i.e., the cap at the non-blade end of the hockey stick) or the blade if it is replaceable. The completely open end will hereafter be referred to as the "pouring end" and the partially closed end (or if also completely open, it will be sealed off by use of a plug as described below) will hereafter be referred to as the "sealed end."

[0033] 2. Cut the stick to remove any damaged areas in the repair joint area of the stick.
3. Remove any plastic sheeting or other material that may inhibit the liquid hardening system from contacting the inside surface of the hockey stick.

4. Sand or abrade the inside of both ends of the joining halves of the hockey stick. Sand up to about 2 inches from the joint.

5. Using grooving bit 30 in a power rotary device, such as a high speed rotary saw, ream grooves on the inside walls of both halves of the hockey stick to enhance physical adhesion and remove any dust and loose debris from the inside of the shaft. Preferably, four grooves should be created, but more or less may be used.

6. Gently position a plug/stopper 62 into the sealed end (bottom half) 64 of the stick. Position the plug/stopper 62 down the hockey stick shaft 64 (i.e., the sealed end of the shaft). For most applications, the preferred position is 1-3/4 inches down the stick of the shaft. An insertion tool 70 (see Fig. 5) may be used to insert the plug/stopper 62 to achieve the desired positioning. Insertion tool 70 has an end 72 of a predetermined length that can motivate the plug/stopper 62 into the sealed end 64 the desired distance. Plug/stopper 62 is to hold the position of the insert 20 and to prevent the liquid hardening system from seeping to the bottom of the sealed end of the stick and thus from weighing the bottom of the stick down. Plug/stopper 62 also keeps a user from improperly fixing the joint by starving the repair area of needed liquid hardening volumes (i.e., the liquid hardening system is kept in the area in and around the fracture area of the stick). Plug/stopper 62 is preferably made of a non-porous/closed-cell foam that is relatively springy so it will hold itself at the desired position inside the bottom half of the hockey stick, and not allow entry or seepage (or just a minimal amount) of the liquid hardening system.

7. Attach bracket system 40 onto a stable work surface using clamp 42.

8. Insert the sealed end 64 of the stick into bracket system 40, using tensioning device 46 to hold the shaft in place. The top of the sealed end 64 is preferably centered with respect to the opening 58 of bracket system 40.

9. Using tensioning device 44, secure the pouring end 66 in the bracket system 40.

10. Using alignment guides 80 (Fig. 6), align or "shim" the sealed end 64 of the stick with the pouring end 66 so that the two portions are properly aligned (vertically or otherwise). Alignment guides 80 are preferably long, substantially rigid structures. They may be straight or curved, depending on the shape of the hollow object. It is preferable to use two alignment guides simultaneously to perform the alignment. If both ends of the
stick do not align properly as demonstrated through the use of alignment guides 80, either portion of the stick may be adjusted slightly while in the bracket system to achieve alignment.

11. Gently position insert 20 into the sealed end 64 of the hockey stick shaft. Position insert 20 down the hockey stick shaft until insert 20 touches the plug/stopper 62.

12. Position the pouring end 66 (i.e., handle portion) of the hockey stick over insert 20.

13. Seal the external joint of the two stick ends with an adhesive tape.

14. Mix the liquid hardening system and pour the liquid hardening system directly into the top of the pouring end 66 (see Fig. 8), down the shaft of the hockey stick. It is important that the liquid hardening system permeate, saturate, or otherwise contact insert 20 while the liquid hardening system is in its most liquid state. It is possible that the liquid hardening system could be inserted by other means such as injection from the side or top.

15. Keep the stick in a straight upright secure position where it will not be disrupted for an extended period of time. Preferably, the stick is left in the bracket system 40 for approximately 24 hours, but can be left in as little as 6 hours. After removal of the stick from the bracket system, it should not be flexed for an additional period of time, preferably 72 hours. The optimal times vary depending on the liquid hardening system used and the temperature of both the liquid hardening system and the shaft.

Not all of the foregoing steps are necessary to effectuate repair of a hockey stick or other hollow object, but are preferred.

Fig. 9 shows the inside of a repaired hollow object such as a hockey stick. The two ends 64, 66 are joined together with the aid of the insert 20. As shown in Fig. 9, some excess dried or cured hardening system 90 may accumulate above the insert 20, but is mostly consumed within center section 10 and fabric 15.

In the foregoing description, it will be readily appreciated by those skilled in the art that modifications may be made to the invention without departing from the concepts disclosed herein. Such modifications are to be considered as included in the following claims, unless these claims by their language expressly state otherwise.
The invention claimed is:

1. A repair kit for hollow objects, the repair kit comprising:
   an insert comprised of at least one inner section and at least one layer of material at
   least partially covering the inner section; and
   a liquid hardening system.

2. The repair kit of claim 1, wherein the at least part of the at least one inner section is
   an open-cell foam.

3. The repair kit of claim 1, wherein the at least one layer of material is a carbon
   fiber.

4. The repair kit of claim 1, wherein the liquid hardening system comprises an epoxy.

5. The repair kit of claim 1, wherein the liquid hardening system comprises a
   bisphenol-A epoxy.

6. The repair kit of claim 1, wherein the liquid hardening system comprises one or
   more systems from the group consisting of polyurethane-based, polyester-based, acrylic-
   based liquid hardening systems.

7. The repair kit of claim 1, wherein the liquid hardening system comprises one or
   more epoxies from the group consisting of bisphenol-A epoxy, bisphenol-F epoxy, and
   mercaptan-based epoxy.

8. The repair kit of claim 2, wherein the at least one layer of material is a carbon
   fiber.

9. The repair kit of claim 8, wherein the liquid hardening system comprises a
   bisphenol-A epoxy.

10. A method of repairing a hollow object, comprising the steps of:
    providing a first hollow piece of an object and a second hollow piece of an object;
providing an insert, at least a portion of which is a material external of a center section;
positioning the insert into the first hollow piece;
positioning the insert into the second hollow piece; and
inserting a liquid hardening system in one of the hollow pieces to contact the insert.

11. The method of repairing a hollow object of claim 10, and further comprising the following steps after the step of providing an insert:
    providing a plug adapted to fit into the first hollow piece and to stop flow of a liquid hardening system therein; and
    inserting the plug into the first hollow piece to a desired location therein.

12. The method of claim 10 and further comprising the step of aligning the first hollow piece with the second hollow piece after the step of positioning the insert into the second hollow piece.

13. The method of claim 10, wherein the hardening system is an epoxy.

14. The repair kit of claim 13, wherein the liquid hardening system comprises one or more epoxies consisting of the group of bisphenol-A epoxy, bisphenol-F epoxy, and mercaptan-based epoxy.

15. The repair kit of claim 10, wherein the liquid hardening system comprises one or more systems from the group consisting of polyurethane-based, polyester-based, acrylic-based liquid hardening systems.

16. The method of claim 10, wherein the center section is an open-cell foam.

17. The method of claim 10 and further comprising the step of creating grooves in the interior of the first hollow piece of the object after the step of providing an insert.
18. The method of claim 10 and further comprising the step of creating grooves in the interior of the second hollow piece of the object after the step of providing an insert.

19. The method of claim 17 and further comprising the step of creating grooves in the interior of the second hollow piece of the object after the step of providing an insert.

20. A hockey stick repair kit, comprising:
   an insert comprised of at least one center section and at least one layer of material at least partially covering the center section;
   a stopper;
   a liquid hardening system; and
   a bracket system.

21. The repair kit of claim 20, wherein the at least one center section is an open-cell foam.

22. The repair kit of claim 20, wherein the at least one layer of material is a carbon fiber.

23. The repair kit of claim 20, wherein the liquid hardening system is a bisphenol-A epoxy system.

24. The repair kit of claim 20, wherein the liquid hardening system comprises one or more epoxies consisting of the group of bisphenol-A epoxy, bisphenol-F epoxy, and mercaptan-based epoxy.

25. The repair kit of claim 20, wherein the liquid hardening system comprises one or more systems from the group consisting of polyurethane-based, polyester-based, acrylic-based liquid hardening systems.

26. The repair kit of claim 20, wherein the liquid hardening system is a bisphenol-A epoxy system.
27. The repair kit of claim 20, and further comprising a securing device to hold the ends of the material in place.

28. A method of repairing a hollow object, comprising the steps of:
   providing a first hollow piece of an object and a second hollow piece of an object;
   providing an insert, at least a portion of which is a material external of a center section;
   providing a bracket system for holding the first hollow piece and second hollow piece in place;
   inserting the first hollow piece and the second hollow piece into the bracket system;
   aligning the first hollow piece with the second hollow piece;
   positioning the insert into the first hollow piece;
   positioning the insert into the second hollow piece; and
   inserting a hardening system in one of the hollow pieces to contact the insert.

29. A device for repairing hollow objects comprising:
   an inner section at least partially surrounded by at least one layer of fabric, the fabric adapted to receive a liquid hardening system and to adhere to the inner walls of a hollow object.

30. The device of claim 29, wherein the inner section is comprised of at least one porous substance.

31. The device of claim 30, wherein the inner section is a combination of open-cell and closed-cell foams.

32. The device of claim 31, wherein the at least one layer of fabric is two or more layers of fabric.