



(51) International Patent Classification:
B29C 65/50 (2006.01)

(21) International Application Number:
PCT/DK201 1/050255

(22) International Filing Date:
1 July 2011 (01.07.2011)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
61/360,927 2 July 2010 (02.07.2010) US
PA 2010 70313 2 July 2010 (02.07.2010) DK

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(81) Designated States (unless otherwise indicated, for every
kind of national protection available): AE, AG, AL, AM,
AO, AT, AU, AZ, BA, BB, BG, BH, BR, BW, BY, BZ,
CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO,
DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT,
HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP,
KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD,
ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI,
NO, NZ, OM, PE, PG, PH, PL, PT, RO, RS, RU, SC, SD,
SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR,
TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) Designated States (unless otherwise indicated, for every
kind of regional protection available): ARIPO (BW, GH,
GM, KE, LR, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG,
ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ,
TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK,
EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU,
LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK,
SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ,
GW, ML, MR, NE, SN, TD, TG).

Published:

— without international search report and to be republished
upon receipt of that report (Rule 48.2(g))

(54) Title: LAP JOINT

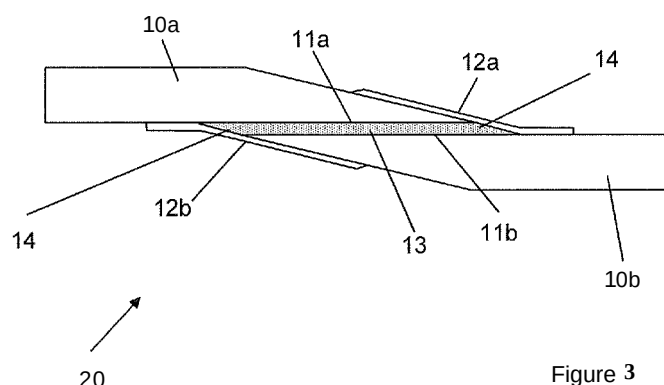


Figure 3

(57) Abstract: A lap joint, the lap joint comprising a first component and a second component; the first component having a first joining surface, the second component having a second joining surface; the first component comprising a first plate adjacent to the first joining surface and protruding from the first component in a direction away from the first joining surface, the first plate being deflectable relative to the first joining surface; wherein the first and second joining surfaces are configured to be bonded together in use, with an adhesive there between, and the first plate controls the spew of adhesive from the first and second joining surfaces.

Lap Joint

The present invention relates to a lap joint. In particular, the present invention relates to joining two components together, so that the spew of adhesive from the joint is controlled.

When large components, such as those components used in the manufacture of wind turbine blades are assembled, there is often the problem that adhesive spews from the joint which can cause a number of problems.

Figure 1 shows a lap joint according to the prior art. Two composite components 1, 2 are bonded together through use of an adhesive 3. However, when the components 1, 2 are forced together under pressure to make the joint, surplus adhesive spews out from the edge of the joint as shown by the beads of adhesive 4. A first problem is that the beads 4 of adhesive do not cure fully as they are not sandwiched between the two composite components. These beads 4 may become detached from the rest of the adhesive and cause a problem. For example, if the joint is in the interior of a wind turbine blade the detached beads may be loose in the interior of the blade and cause damage to components. A second problem is that an undercut in the bead 4 is present as shown by arrow 5. This undercut may result in a crack in the adhesive 3 propagating along the joining surfaces.

It is an aim of the present invention to provide a joint which avoids the problems mentioned above.

According to a first aspect of the present invention there is provided a lap joint, the lap joint comprising a first component and a second component; the first component having a first joining surface, the second component having a second joining surface; the first component comprising a first plate adjacent to the first joining surface and protruding from the first component in a direction away from the first joining surface, the first plate being deflectable relative to the first joining surface; wherein the first and second joining surfaces are configured to be bonded together in use, with an adhesive therebetween, and the first plate controls the spew of adhesive from the first and second joining surfaces.

By "spew of adhesive" is meant the excess adhesive that is forced from the joining surfaces when they are bonded to each other under a force. By controlling the spew

of adhesive means that the adhesive will be cured and there will be no undercuts in the adhesive from which a crack could propagate. Therefore, if the lap joint is located in the interior of a wind turbine blade for example, it can be ensured that there is no loose adhesive that will break off from the joint and the joint will be stronger.

By "lap joint" is meant a joint between two components or substrates where opposing surfaces of the two components are joined together.

10 Preferably, the first plate is configured such that when the first and second components are bonded together, the first plate is deflected by the second component. The first plate may be thin so that it can deflect relative to the first joining surface, by being forced into position by the second component.

15 The second component may comprise a second plate adjacent to the second joining surface and protruding from the second component in a direction away from the second joining surface, the second plate being deflectable relative to the second surface; wherein the first and second joining surfaces are configured to be bonded together in use, with an adhesive therebetween, and the first plate and the second
20 plate control the spew of adhesive from the first and second joining surfaces. By providing a plate on each component allows the spew of adhesive to be controlled at each end of the lap joint from where the adhesive may be expected to spew.

Preferably, the first plate and the second plate are configured such that when the first
25 and second components are bonded together, the first plate is deflected by the second component and the second plate is deflected by the first component. The second plate may be thin so that it can deflect relative to the second joining surface, by being forced into position by the first component.

30 The first and second plates may be formed from composite material bonded to the first and second components, respectively. Such a composite material may be GFRP or CFRP. The bonding may be through adhesive or mechanical fixings, such as screws or rivets for example. By bonding the plates to the components means that existing components can be retrofitted with the plates. The plates may also be
35 formed from plastic or another suitable material in another example.

The first and second plates may be formed integrally with the first and second components, respectively. Preferably, this would be through fabricating the components and the plates in the same mould which will reduce manufacturing and assembly time.

5

The first and second plates may protrude from an end of the first and second components, respectively. The "end" of the first and second components will be the position at which adhesive would spew from if the plates were not provided.

10 Preferably, the first and second components are formed from a composite material.

Preferably, the first and second plates are formed from a sheet of composite material.

15 According to a second aspect of the present invention there is provided a component for use in a lap joint, the component comprising: a joining surface; a plate adjacent to the joining surface and protruding from the component in a direction away from the joining surface, the plate being deflectable relative to the joining surface; wherein the joining surface is configured to be bonded, in use, with a joining surface on a further
20 component with an adhesive therebetween, and the plate controls the spew of adhesive from the joining surfaces.

According to the invention, a spar for a wind turbine blade may be provided, the spar comprising a lap joint according to the first aspect of the invention. According to the
25 invention a wind turbine blade may comprise the spar. According to the invention the wind turbine may have at least one of the wind turbine blades. Such a wind turbine may be a three bladed horizontal axis wind turbine.

The invention will now be described by way of example only with reference to the
30 following Figures in which:

Figure 1 is a schematic view of a lap joint according to the prior art.

Figure 2 is a schematic view of a component according to the present invention.

Figure 3 is a schematic view of a lap joint according to the present invention.

Figure 4 is a view of a part of a wind turbine blade spar.

35 Figure 5 is a schematic view of a mould for fabricating a component according to the present invention.

Figure 2 shows a composite component 10 formed from a GFRP (glass fibre reinforced plastic) or CFRP (carbon fibre reinforced plastic). The composite component 10 includes a joining surface 11 which in use is bonded to a second composite component by an adhesive. The composite component comprises a plate 12 (referred to as a spew control plate) which is adjacent to the joining surface 11 and projects away from the joining surface. That is, the joining surface 11 forms a planar surface and the plate 12 is orientated at an angle relative to the joining surface as can be seen by the acute angle marked as 13 in Figure 2.

The plate 12 in this example is formed from composite material integral with the composite component as described below with respect to Figure 5. The plate 12 is formed from a thin flexible sheet of composite material so that it can deflect relative to the joining surface 11. This deflection is shown by the double headed arrow in Figure 2.

When a second composite component is bonded to the composite component 10 the plate 12 is deflected so that it controls the spew of adhesive from the joint as shown in Figure 3. The adhesive may be, for example, epoxy or polyurethane.

Figure 3 shows a lap joint 20 formed from a first composite component 10a and a second composite component 10b. Each composite component 10a, 10b has a joining surface 11a, 11b and a plate 12a, 12b, respectively. An adhesive 13 is placed between the two joining surfaces 11a, 11b and the joint 20 is formed by applying pressure to the two composite components 10a, 10b to force them together.

As the composite components 10a, 10b are forced together, the flexible plates 12a, 12b are forced to deflect when they come in contact with the opposing composite component. When the plates 12 are deflected they are put under tension so they will attempt to return to their original unloaded state if no force is applied. Therefore, the plates 12 form a barrier against the opposing composite component which inhibits any surplus adhesive 13 from forming a bead such as that shown in the prior art of Figure 1.

Furthermore, the plates 12 contain the adhesive 13 so that it forms a triangular spew fillet 14 at the ends of the adhesive 13. The triangular spew fillet 14 reduces the shear stress and provides an improved stress distribution in the adhesive 13 - this reduces the likelihood of crack propagation and improves the fatigue performance of the joint 20.

Figure 4 illustrates the invention in use in a wind turbine blade spar 30. Although the invention is applicable to the joining of any two components, this example is described with reference to a wind turbine blade component. The spar 30 is a structural member that extends along the length of a wind turbine blade from a root end of the blade to a tip end of the blade. In use, an aerodynamic shell is fixed to the spar to create the wind turbine blade. The spar 30 comprises two spar caps 21a, 21b and two shear webs 22a, 22b arranged in a box shape. The spar caps 21a, 21b are fixed to the aerodynamic shells (not shown) and the shear webs 22a, 22b maintain the distance between the two spar caps.

The spar caps 21a, 21b and the shear webs 22a, 22b are pre-manufactured in moulds prior to being assembled into the spar 30. In this example, the spar caps 21a, 21b are formed from carbon fibre embedded in a thermoset resin matrix and the shear webs 22a, 22b are formed from glass fibre embedded in a thermoset resin matrix. The spar caps and the shear webs are pre-fabricated in a mould and then cured so that they are solid components prior to being assembled into the spar 30. The fabrication of the spar caps and the shear webs can be carried out using any well known composite manufacturing method known in the art, i.e. using prepreg technology or resin infusion. As shown in Figure 4, the shear webs 22a, 22b are fixed to the spar caps 21a, 21b at a joint region in each corner which extends along the length of the spar 30.

There are four joint regions in the spar 30. However for clarity the spew control plates are only shown in the top two joints in Figure 4. The bottom two joints as viewed in Figure 4 do not include the spew control plates. However, it should be appreciated that the spew control plates will be provided at each joint. No adhesive is shown in Figure 4 for clarity.

The spar cap 21a includes two spew control plates 23a, 23b which project from the spar cap adjacent to the joining surface. The shear webs 22a, 22b includes two spew control plates 24a, 24b which project from the shear webs adjacent to the joining surface. As described above in relation to Figures 2 and 3 the plates control the spew from the joint region.

Figure 5 is an example of how the spew control plates may be fabricated on a shear web. A mould 40 is provided with a primary moulding surface 41. The mould 40 also

includes secondary moulding surfaces 42 at an angle to the primary moulding surface 41. To construct the shear web, layers 43 of GFRP pre-impregnated (prepreg) material is laid on the primary mould surface 41. A foam core 44 is then placed on the layers of prepreg, and further layers 43 of GFRP are laid on the foam core 44. To fabricate the spew control plates, a layer 45 of GFRP is provided at the secondary moulding surfaces 42. The layers of GFRP and the foam core are sealed in a vacuum bag (not shown) and cured under the application of heat as is well known in the art of composite manufacturing. When the shear web is removed from the mould 40, the spew control plates will be present, formed as an integral component with the shear web.

The spew control plates are thin, typically less than 1 millimetre in thickness and may be formed from a single sheet of GFRP or CFRP.

The spew control plates may also be fabricated separately and attached to the composite components by means of adhesive or mechanical fixings such as screws or rivets.

Claims

1. A lap joint, the lap joint comprising a first component and a second component;

5 the first component having a first joining surface, the second component having a second joining surface;

the first component comprising a first plate adjacent to the first joining surface and protruding from the first component in a direction away from the first joining surface, the first plate being deflectable relative to the first joining surface; wherein

10 the first and second joining surfaces are configured to be bonded together in use, with an adhesive therebetween, and the first plate controls the spew of adhesive from the first and second joining surfaces.

2. A joint according to 1, wherein the first plate is configured such that when the
15 first and second components are bonded together, the first plate is deflected by the second component.

3. A joint according to claim 1 or claim 2, wherein the second component comprises a second plate adjacent to the second joining surface and protruding from
20 the second component in a direction away from the second joining surface, the second plate being deflectable relative to the second surface; wherein

the first and second joining surfaces are configured to be bonded together in use, with an adhesive therebetween, and the first plate and the second plate control the spew of adhesive from the first and second joining surfaces.

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4. A joint according to claim 3, wherein the first plate and the second plate are configured such that when the first and second components are bonded together, the first plate is deflected by the second component and the second plate is deflected by the first component.

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5. A joint according to claim 3 or claim 4, wherein the first and second plates are formed from composite material bonded to the first and second components, respectively.

35 6. A joint according to claim 3 or claim 4, wherein the first and second plates are formed integrally with the first and second components, respectively.

7. A joint according to any one of claims 3 to 6, wherein the first and second plates protrude from an end of the first and second components, respectively.

8. A joint according to any one of claims 3 to 7, wherein the first and second components are formed from a composite material.

9. A joint according to any one of claims 3 to 8, wherein the first and second plates are formed from a sheet of composite material.

10. A component for use in a lap joint, the component comprising:
a joining surface;
a plate adjacent to the joining surface and protruding from the component in a direction away from the joining surface, the plate being deflectable relative to the joining surface; wherein
the joining surface is configured to be bonded, in use, with a joining surface on a further component with an adhesive therebetween, and the plate controls the spew of adhesive from the joining surfaces.

11. A spar for a wind turbine blade, the spar comprising a lap joint according to any one of claims 1 to 9.

12. A wind turbine blade comprising a spar according to claim 11.

13. A wind turbine having at least one wind turbine blade according to claim 12.

1/2

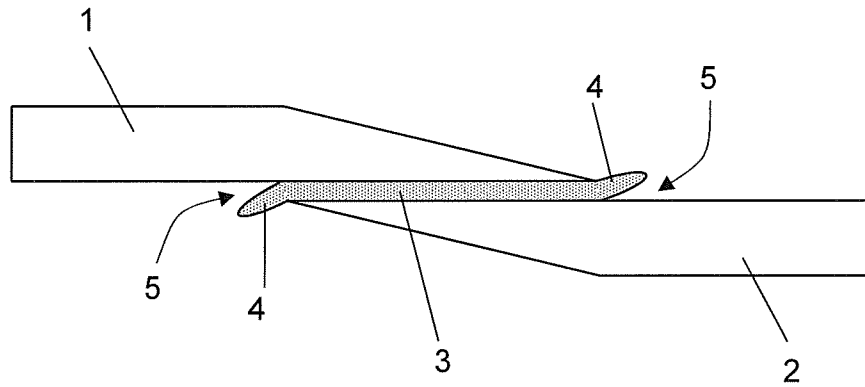


Figure 1

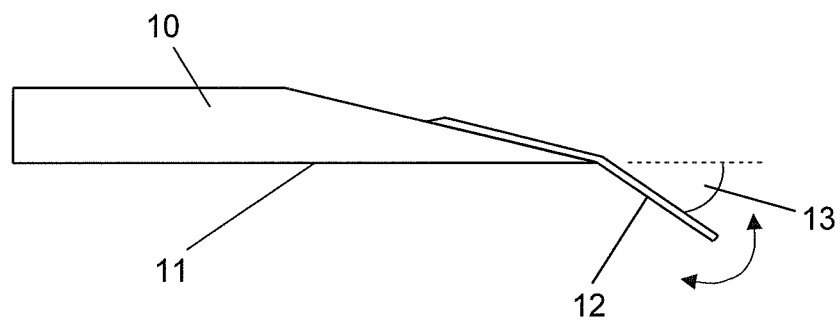


Figure 2

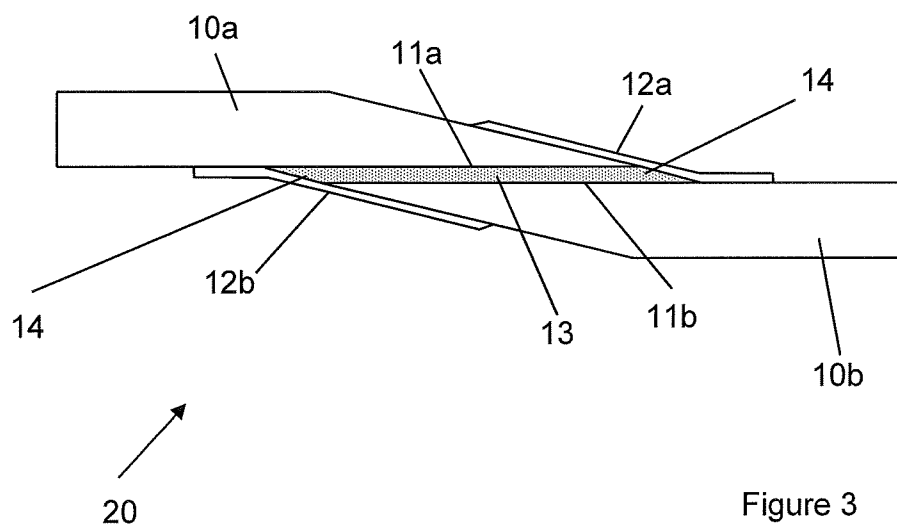


Figure 3

2/2

