

TITLE: A blade assembly for a mast connected to a wind turbine, a mast of a wind-power plant and use of a blade assembly

5 Field of the invention

The present invention relates to a blade assembly for a mast connected to a wind turbine. The blade assembly is configured to be attached to the mast that transfers energy to the wind turbine. The blade assembly comprises a primary blade
10 comprising a primary attachment part configured to be attached to the mast, and a primary airfoil protruding from the primary attachment part. The blade assembly further comprises a biplane blade connected to the primary blade. The biplane blade extends between a first connection and a second connection to the primary blade. The biplane blade comprises a biplane airfoil between the first connection and the
15 second connection.

The present invention also relates to a mast of a wind-power plant comprising the blade assembly and use of the blade assembly.

20 Background of the invention

Wind power plants use blade assemblies connected to masts for transferring rotational energy to turbines. The rotational energy may be directly transferred to the turbine, such as in a horizontal-axis wind turbine (HAWT), or alternatively transferred
25 to the turbine by means of the mast, such as in a vertical-axis wind turbine (VAWT).

During use of the blade assemblies in the wind power plants, the blade assemblies are subjected to large forces and moments. For purpose of improving the efficiency of the wind power plants, it is desirable to arrange the blade assemblies with high
30 lengths. This however result in that high forces and moments are subjected to the blade assemblies. To withstand these forces and moments, the blade assemblies are often constructed using various exclusive materials, such as fiber reinforced polymer, carbon fiber, etc. While providing high strength, a problem with such materials is that they are costly and contribute significantly to the overall cost of the
35 wind power plant.

It is desirable to use less costly materials, such as an aluminum alloy or wood, for providing the structural strength of the blade assemblies.

US2014363303A1 discloses a wind turbine blade with a biplane section.

5

Summary of the invention

An object of the present invention is to provide an improved blade assembly for a wind-power plant. In particular, a first object of the invention is to provide an improved blade assembly that enables use of less costly construction materials, such as an aluminum alloy or wood, or combination thereof. A second object of the invention is to provide an improved blade assembly that enables it to be constructed with higher length compared with prior art blade assemblies. A third object of the invention is to provide an improved blade assembly suitable for use in connection to a horizontal-axis wind turbine (HAWT).

These objects are obtained by means of a blade assembly for a mast connected to a wind turbine, wherein the blade assembly is configured to be attached to the mast. The blade assembly comprises

- a primary blade comprising a primary attachment part configured to be attached to the mast, and a primary airfoil protruding from the primary attachment part, and
- a biplane blade connected to the primary blade, wherein the biplane blade extends between a first connection and a second connection to the primary blade, wherein the biplane blade comprises a biplane airfoil between the first connection and the second connection, and
- a primary strut configured to be connected between the primary blade and the mast.

The primary blade has the function as a main absorber of energy from the wind using the primary airfoil. The primary blade defines the overall the length of the blade assembly. The biplane blade is connected to the primary blade by means of the first connection and the second connection. The biplane blade has the function as a sub-absorber of energy from the wind using the biplane airfoil. Together, the primary blade and the biplane airfoil absorb energy from the wind.

35

The biplane blade further has the function of providing structural stability to the primary blade. The structure stability of the primary blade is further improved by the

primary strut extending between the primary blade and the mast. The main function of the primary strut is to absorb thrust forces subjected to the primary blade. The biplane blade together with the primary strut improve the structural stability of the primary blade.

5

By means of the configuration of the blade assembly, the structural stability of the blade assembly as a whole is improved, which enables use less costly materials, such as an aluminum alloy or wood, or combination thereof. Alternatively, exclusive materials such as fiber reinforced polymer, carbon fiber, etc. may be used in order to further increase the length of the blade assembly compared with prior art blade assemblies.

According to an embodiment of the invention, the primary attachment part is configured to be attached to a first part of the mast and the primary strut is configured to be connected to a second part of the mast, wherein the first part and the second part of the mast are separated by a distance from each other. By means of arranging the attachment of the primary blade to the mast and the attachment of the primary strut to the mast separated from each other. The stability of the blade assembly is improved.

20

According to an embodiment of the invention, the primary blade comprises a tip portion, and wherein the first connection and the second connection of the biplane blade to the primary blade is located between the primary attachment part and the tip of the primary blade. The primary blade extends from the primary attachment part to the tip portion. By connecting the biplane blade between the primary attachment part and the tip portion the structural stability of the blade assembly is improved.

According to an embodiment of the invention, the first connection of the biplane blade to the primary blade is located adjacent to the primary attachment part.

30

According to an embodiment of the invention, the second connection of the biplane blade to the primary blade is located adjacent to the tip portion of the primary blade.

According to an embodiment of the invention, the biplane blade is shorter than the primary blade, wherein the length of the biplane blade between the first connection and the second connection constitutes 30 – 70 % the length of the primary blade, preferably 40 – 60 % the length of the primary blade. The main function of the

35

biplane blade is to support the primary blade and for this purpose it is sufficient that biplane blade is shorter than the primary blade.

5 According to an embodiment of the invention, the biplane blade is arranged centered mid-blade to the primary blade.

10 According to an embodiment of the invention, the second connection of the biplane blade to the primary blade is located at a distance from the primary attachment part that comprises between one third to two thirds the length of the primary blade, preferably half the length of the primary blade. The main function of the biplane blade is to support the primary blade and for this purpose it is preferable that the second connection is mid-blade at a distance from tip portion.

15 According to an embodiment of the invention, the biplane blade comprises a first part extending from the first connection and away from the primary blade such that a first space is formed between said first part and the primary blade, wherein a first portion of the biplane airfoil is arranged on said first part.

20 According to an embodiment of the invention, the biplane blade comprises a second part extending from the second connection and away from the primary blade such that a second space is formed between said second part and the primary blade, wherein a second portion of the biplane airfoil is arranged on said second part.

25 According to an embodiment of the invention, a chord line of the first portion of the biplane airfoil is larger than a chord line of the second portion of the biplane airfoil.

According to an embodiment of the invention, a chord line of the second portion of the biplane airfoil is larger than a chord line of the first portion of the biplane airfoil.

30 According to an embodiment of the invention, the blade assembly further comprises a secondary strut connected between the primary blade and the biplane blade. The structural stability of the connection between the primary blade and the biplane blade is improved by the secondary strut extending between the primary blade and the biplane blade. The main function of the secondary strut is to absorb thrust forces
35 between the primary blade and the biplane blade.

According to an embodiment of the invention, the biplane blade comprises a connection part where the first part and the second part of the biplane blade are connected, wherein the secondary strut is connected to the connection part. By connecting the secondary strut to the connection part between the first part and the
5 second part of the biplane blade, the structural stability of the biplane blade is improved.

According to an embodiment of the invention, the connection part between the first part and the second part of the biplane blade is located further away from the
10 primary blade than the first part and the second part of the biplane blade.

According to an embodiment of the invention, the primary strut is connected to the primary blade at an angle in an interval of ± 25 degree perpendicular to the extension of the primary blade, preferably ± 10 degree perpendicular to the
15 extension of the primary blade.

According to an embodiment of the invention, the secondary strut is connected to the biplane blade at an angle in an interval of ± 25 degree perpendicular to the extension of the biplane blade, preferably ± 10 degree perpendicular to the
20 extension of the biplane blade.

According to an embodiment of the invention, a chord line of the airfoil of the biplane blade is smaller than a chord line of the airfoil of the primary blade. The main function of the biplane blade is to support the primary blade and for this purpose it is
25 preferable that the chord line of the airfoil of the biplane blade is smaller than the chord line of the airfoil of the primary blade. Thereby, the primary blade act as the main absorber of energy from the wind.

According to an embodiment of the invention, the chord line of the airfoil of the biplane blade is in an interval of 10 – 50 % of the chord line of the airfoil of the primary blade, preferably 20 – 30 % of the chord line of the airfoil of the primary
30 blade.

According to an embodiment of the invention, the secondary strut comprises at least
35 one beam that is arranged streamlined in respect to a direction of displacement of the blade assembly. By means of the streamlined arrangement of the at least one

beam, the drag from the secondary strut to the rotation of the blade assembly is reduced.

5 According to an embodiment of the invention, the secondary strut comprises two or more beams connected extending between different locations of the primary blade and the biplane blade. By means of arranging the secondary strut with two or more beams, the structural stability of the connection between the primary blade and the biplane blade is improved.

10 According to an embodiment of the invention, the primary attachment part of the primary blade comprises two attachment portions separated from each other, wherein the two attachment portions are configured to form an attachment to the mast.

15 According to an embodiment of the invention, a connection part of the primary strut comprises two attachment portions separated from each other, wherein the two attachment portions are configured to form an attachment to the mast.

20 According to an embodiment of the invention, the primary blade and the biplane blade mainly comprises one of aluminum and wood, or a combination thereof.

According to an embodiment of the invention, a tip of the primary blade comprises a leading edge comprising a layer of one of steel, titanium and aluminum, or a combination thereof.

25 According to an embodiment of the invention, at least one of the primary blade and the biplane blade comprises a beam assembly, preferably a box beam assembly, and an aerodynamic shell fixed to the beam assembly. The beam assembly has the function of providing the main structural stability to the primary blade and/or the
30 biplane blade. The aerodynamic shell has the function of forming the primary airfoil and/or the biplane airfoil.

According to an embodiment of the invention, the aerodynamic shell comprises a core and an inner- and outer layer attached to the core, wherein the core mainly
35 comprising one of a biological derived composition, preferably wood, a honeycomb structure of para-aramid synthetic fiber composition or aluminum, a metal foam and

a polymer foam, preferably mainly comprising divinycells, wherein the inner- and outer layer mainly comprises a sheet of an aluminum alloy.

5 According to an embodiment of the invention, the core, the inner- and outer layer are bound together with an adhesive, preferably epoxy.

10 According to an embodiment of the invention, the sheet of an aluminum alloy of the inner- and outer layer have been joined by means of friction-stir-welding. Friction stir welding is in particular suitable for connecting rigid sheets of an aluminum alloy.

15 According to an embodiment of the invention, the beam assembly comprises a beam mainly comprising an aluminum alloy.

20 According to an embodiment of the invention, the primary blade, the biplane blade, the primary strut and the secondary strut are made of separate elements.

25 According to an embodiment of the invention, the beam assembly of the primary blade and the biplane blade have been joined together by means of friction stir welding.

30 According to an embodiment of the invention, at least one of the primary blade and the biplane blade comprises a leading edge along its extension, wherein the leading edge comprises a reinforced layer of one of steel, titanium and aluminum, or a combination thereof. By means of providing the leading edge with a reinforced outer layer at the leading edge, the problem with erosion at the leading edge is reduced.

35 According to an embodiment, the outer layer, for example in form of a layer of an aluminum alloy, on the core at the leading edge may partly or fully replace the outer layer.

40 According to an embodiment of the invention, the blade assembly comprises pin joints configured to hold the primary blade, the biplane blade, the primary strut and the secondary strut rotatably attached at their respective attachment during assembling the blade assembly. By means of the pin joints, the assembling of the blade assembly is facilitated.

45 According to an embodiment of the invention, the blade assembly comprises locking means configured to lock the pin joints from rotation after completion of assembling

the blade assembly. By means of the locking means, permanent attachments of the primary blade, the biplane blade, the primary strut and the secondary strut are established.

- 5 The object of the invention is further obtained by means of a mast of a wind-power plant comprising a blade assembly according to any of the above embodiments.

The object of the invention is further obtained by use of a blade assembly according to any of the above embodiments.

10

Description of the figures

Embodiments of the present invention will now be described, by way of example only, with reference to the following figures, wherein:

- 15 Figure 1a discloses a schematic overview of a blade assembly according to an embodiment of the invention,
Figure 1b discloses a schematic overview of a blade assembly according to further embodiment of the invention,
Figure 1c discloses a schematic overview of a blade assembly according to yet
20 another embodiment of the invention,
Figure 2 discloses embodiments of the primary blade, the biplane blade and the primary strut as separate elements,
Figure 3 discloses a cross section of a primary blade according to an embodiment of the invention, and
25 Figure 4 discloses a schematic overview of a blade assembly according to further embodiment of the invention.

Description of preferred embodiments of the invention

- 30 Fig. 1 discloses a schematic overview of a blade assembly 1 according to an embodiment of the invention. The blade assembly 1 is shown connected to a mast 5 of a wind power plant.

- The blade assembly 1 comprises a primary blade 10 comprising a primary
35 attachment part 12 attaching the primary blade 10 to the mast 5. The primary blade 10 extends from the primary attachment part 12 to a tip portion 14. The primary blade 10 comprises a primary airfoil 16 between the primary attachment part 12 and

the tip portion 14. The primary airfoil 16 may be arranged fully or partly between the primary attachment part 12 and the tip portion 14.

5 The blade assembly 1 further comprises a biplane blade 20 connected to the primary blade 10. The biplane blade 20 comprises a first connection 22 and a second connection 24 to the primary blade 10. The biplane blade 20 further comprises a biplane airfoil 26 between the first connection 22 and the second connection 24.

10 Preferably, a chord line of the biplane airfoil 26 of the biplane blade 20 is smaller than a chord line of the primary airfoil 16 of the primary blade 10. Preferably, the chord line of the biplane airfoil 26 of the biplane blade 20 is in an interval of 10 – 50 % of the chord line of the primary airfoil 16 of the primary blade 10, preferably 20 – 30 % of the chord line of the primary airfoil 16 of the primary blade 10.

15 The blade assembly 1 further comprises a primary strut 30 extending from the mast 5 to the primary blade 10. The primary strut 30 comprises a first primary strut connection 32 connecting the primary strut 30 to the mast 5, and a second primary strut connection 34 connecting the primary strut 30 to the primary blade 10. The primary blade 10 is connected to a first part 12a of the mast 5 by means of the
20 primary attachment part 12. The primary strut 30 is connected to a second part 32a of the mast 5 by means of the primary strut connection 32. In the disclosed embodiment, the first part 12a of the mast 5 and the second part 32a of the mast 5 are located separated from each other. However, it shall be understood that the first part 12a of the mast 5 and the second part 32a of the mast 5 may be arranged
25 adjacent to each other.

The blade assembly 1 further comprises a secondary strut 40 connected between the primary blade 10 and the biplane blade 20. The secondary strut 40 comprises a first secondary strut connection 42 connecting the secondary strut 40 to the primary
30 blade 10, and a second secondary strut connection 44 connecting the secondary strut 40 to the biplane blade 20. In the disclosed embodiment in fig. 1, the primary strut 30 and the secondary strut 40 are separate elements. However, it shall be understood that the primary strut 30 and the secondary strut 40 may be comprised by a combined element.

35 In the disclosed embodiment, the biplane blade 20 is shorter than the primary blade 10. Preferably, the length of the biplane blade 20 between the first connection 22

and the second connection 24 constitutes 30 – 70 % the length of the primary blade 10, preferably 40 – 60 % the length of the primary blade 10.

5 The biplane blade 20 comprises a first part 20a extending from the first connection 22 and away from the primary blade 10 such that a first space 28a is formed between the first part 20a and the primary blade 10. A first portion 26a of the biplane airfoil 26 is arranged on the first part 20a.

10 Correspondingly, the biplane blade 20 comprises a second part 20b extending from the second connection 24 and away from the primary blade 10 such that a second space 28b is formed between the second part 20b and the primary blade 10. A second portion 26b of the biplane airfoil 26 is arranged on the second part 20b.

15 The biplane blade 20 further comprises a connection part 29 where the first part 20a and the second part 20b of the biplane blade 20 are connected. In the disclosed embodiment, the secondary strut 40 is connected to the connection part 29. In the disclosed embodiment, the first part 20a and the second part 20b of the biplane blade 20 are of similar length. However, it shall be understood that the first part 20a and the second part 20b of the biplane blade 20 may have different length.

20 In the disclosed embodiment, the connection part 29 between the first part 20a and the second part 20b of the biplane blade 20 is located further away from the primary blade 10 than the first part 20a and the second part 20b of the biplane blade 20. Accordingly, the connection part 29 forms a tip of the biplane blade 20.

25 In the disclosed embodiment, the primary strut 30 is connected mid-blade to the primary blade 10 by means of the second primary strut connection 34. The biplane blade 20 is preferably arranged extending symmetrical in respect to the mid-blade location. It shall be understood that the biplane blade 20 may be arranged
30 alternatively. For example, the first connection 22 of the biplane blade 20 to the primary blade 10 may be located adjacent to the primary attachment part 12 of the primary blade 10. Correspondingly, the second connection of 24 the biplane blade 20 to the primary blade 10 may be located adjacent to the tip 14 portion of the primary blade 10.

35 In the disclosed embodiment, the primary strut 30 is connected essentially perpendicular to the extension of the primary blade 10 by means of the second

primary strut connection 34. However, it shall be understood that the primary strut 30 may connected to the primary blade 10 at an angle in an interval of +/- 25 degree perpendicular to the extension of the primary blade 10, preferably +/- 10 degree perpendicular to the extension of the primary blade 10.

5

In the disclosed embodiment, the secondary strut 40 is connected essentially perpendicular to the biplane blade 20 at the connection part 29 by means of the second secondary strut connection 44. However, it shall be understood that the secondary strut 40 may be connected to the biplane blade 20 at an angle in an interval of +/- 25 degree perpendicular to the extension of the biplane blade 20, preferably +/- 10 degree perpendicular to the extension of the biplane blade 20.

10

According to an embodiment of the invention, the secondary strut 40 comprises at least one beam that is arranged streamlined in respect to a direction of displacement of the blade assembly 1. In the disclosed embodiment, a single beam of the secondary strut 40 strut is indicated. However, it shall be understood that the secondary strut 40 may comprise two or more beams connected extending between different locations of the primary blade 10 and the biplane blade 20.

15

With reference to fig. 1b, a further embodiment of the invention is disclosed. The embodiment in fig. 1b differs from the embodiment in fig. 1a in that the primary strut 30 and the secondary strut 40 are in the form of a single unit. Accordingly, connections to the primary blade 10 and the biplane blade 20 relate to connections to the primary strut 30 and the secondary strut 40 as a single unit.

25

With reference to fig. 1c, yet another embodiment of the invention is disclosed. The invention differs from the embodiments in fig. 1a and 1b in that the blade assembly 1 lacks the secondary strut 40. The primary blade 10 further is extending curved whereas the biplane blade 20 is extending essentially straight.

30

With reference to fig. 2, embodiments of the primary blade 10, the biplane blade 20 and the primary strut 30 as separate elements are disclosed. It shall be understood that the element indicated as the primary strut 30 in fig. 2 may have the function of both the primary strut 30 and the secondary strut 40.

35

In the disclosed embodiment, the primary attachment part 12 of the primary blade 10 comprises two attachment portions 13a, 13b separated from each other. The two attachment portions 13a, 13b are configured to form an attachment to the mast 5.

- 5 Correspondingly, the primary strut connection 32 of the primary strut 30 comprises two attachment portions 33a, 33b separated from each other. The two attachment portions 33a, 33b are configured to form an attachment to the mast 5.

According to an embodiment of the invention, the primary blade 10 and the biplane
10 blade 20 mainly comprises one of aluminum and wood, or a combination thereof. The combination of wood and aluminum provides structural strength to the blade assembly 1.

According to an embodiment of the invention, the tip portion 14 of the primary blade
15 10 comprises a leading edge comprising a layer of one of steel, titanium and aluminum, or a combination thereof.

With reference to fig. 3, a cross section of a primary blade 10 according to an
embodiment of the invention is disclosed. Corresponding embodiment is applicable
20 to the biplane blade 20. The primary blade 10 comprises a beam assembly 50 and an aerodynamic shell 52 fixed to the beam assembly 40. The beam assembly 50 is preferably a box beam assembly.

The aerodynamic shell 52 comprises a layered structure comprising a core 60 and
25 an inner layer 62 and outer layer 64 attached to the core 60. The core 60, the inner layer 62 and the outer layer 64 are preferably bound together with an adhesive, preferably epoxy. The inner layer 62 and outer layer 64 are preferably a sheet of an aluminum alloy that have been joined by means of friction-stir-welding.

30 According to an embodiment of the invention, the core 60 mainly comprising one of a biological derived composition, preferably wood, a honeycomb structure of para-aramid synthetic fiber composition or aluminum, a metal foam and a polymer foam, preferably mainly comprising divinycells. The inner layer 62 and the outer layer 64 mainly comprising a sheet of an aluminum alloy.

35 With reference to fig. 4, a schematic overview of a blade assembly 1 according to a further embodiment of the invention is disclosed. The blade assembly 1 comprises

pin joints 70 configured to hold the primary blade 10, the biplane blade 20, the primary strut 30 and the secondary strut 40 rotatably attached at their respective attachment during assembling the blade assembly 1.

- 5 According to an embodiment of the invention, the blade assembly 1 comprises locking means configured to lock the pin joints 70 from rotation after completion of assembling the blade assembly 1. The locking means are not indicated in the figures.
- 10 It should be noted that the above-mentioned embodiments illustrate rather than limit the invention, and that those skilled in the art will be able to design many alternative embodiments without departing from the scope of the appended claims.

- For example, it shall be understood that features and embodiments relating to the structure of the beam assembly 50 and the aerodynamic shell 52 may be applied independently of the features relating to the structural configuration of the blade assembly 1.
- 15

Claims

1. A blade assembly (1) for a mast (5) connected to a wind turbine, wherein the blade assembly (1) is configured to be attached to the mast (5), wherein the blade
5 assembly (1) comprises
- a primary blade (10) comprising a primary attachment part (12) configured to be attached to the mast (5), and a primary airfoil (16) protruding from the primary attachment part (12),
- a biplane blade (20) connected to the primary blade (10), wherein the biplane blade
10 (20) extends between a first connection (22) and a second connection (24) to the primary blade (10), wherein the biplane blade (20) comprises a biplane airfoil (26) between the first connection (22) and the second connection (24),
characterized in that
the blade assembly (1) further comprises a primary strut (30) configured to be
15 connected between the primary blade (10) and the mast (5).
2. The blade assembly (1) according to claim 1, wherein the primary attachment part (12) is configured to be attached to a first part (12a) of the mast (5) and the primary strut (30) is configured to be connected to a second part (32a) of the mast (5),
20 wherein the first part and the second part of the mast (5) are separated by a distance from each other.
3. The blade assembly (1) according to any of claim 1 and 2, wherein the primary blade (10) comprises a tip portion (14), and wherein the first connection (22) and the
25 second connection (24) of the biplane blade (20) to the primary blade (10) is located between the primary attachment part (12) and the tip portion (14) of the primary blade (10).
4. The blade assembly (1) according to any of the previous claims, wherein the first
30 connection (22) of the biplane blade (20) to the primary blade (10) is located adjacent to the primary attachment part (12).
5. The blade assembly (1) according to any of claim 3-4, wherein the second
connection (24) of the biplane blade (20) to the primary blade (10) is located
35 adjacent to the tip portion (14) of the primary blade (10).

6. The blade assembly (1) according to any of the previous claims, wherein the biplane blade (20) is shorter than the primary blade (10), wherein the length of the biplane blade (20) between the first connection (22) and the second connection (24) constitutes 30 – 70 % the length of the primary blade (10), preferably 40 – 60 % the length of the primary blade (10).
7. The blade assembly (1) according to any of the previous claims, wherein the biplane blade (20) is arranged centered mid-blade to the primary blade (10).
8. The blade assembly (1) according to any of the previous claims, wherein the biplane blade (20) comprises a first part (20a) extending from the first connection (22) and away from the primary blade (10) such that a first space (28a) is formed between said first part (20a) and the primary blade (10), wherein a first portion (26a) of the biplane airfoil (26) is arranged on said first part (20a).
9. The blade assembly (1) according to any of the previous claims, wherein the biplane blade (20) comprises a second part (20b) extending from the second connection (24) and away from the primary blade (10) such that a second space (28b) is formed between said second part (20b) and the primary blade (10), wherein a second portion (26a) of the biplane airfoil (26) is arranged on said second part (20b).
10. The blade assembly (1) according to claim 9, wherein a chord line of the first portion (26a) of the biplane airfoil (26) is larger than a chord line of the second portion (26b) of the biplane airfoil (26).
11. The blade assembly (1) according to claim 9, wherein a chord line of the second portion (26b) of the biplane airfoil (26) is larger than a chord line of the first portion (26a) of the biplane airfoil (26).
12. The blade assembly (1) according to any of claim 9-11, wherein blade assembly (1) further comprises a secondary strut (40) connected between the primary blade (10) and the biplane blade (20).
13. The blade assembly (1) according to claim 12, wherein the biplane blade (20) comprises a connection part (29) where the first part (20a) and the second part (20b)

of the biplane blade (20) are connected, wherein the secondary strut (40) is connected to the connection part (29).

14. The blade assembly (1) according to claim 13, wherein the connection part (29) between the first part (20a) and the second part (20b) of the biplane blade (20) is located further away from the primary blade (10) than the first part (20a) and the second part (20b) of the biplane blade (20).

15. The blade assembly (1) according to any of the previous claims, wherein the primary strut (30) is connected to the primary blade (10) at an angle in an interval of ± 25 degree perpendicular to the extension of the primary blade (10), preferably ± 10 degree perpendicular to the extension of the primary blade (10).

16. The blade assembly (1) according to any of claim 12-15, wherein the secondary strut (40) is connected to the biplane blade (20) at an angle in an interval of ± 25 degree perpendicular to the extension of the biplane blade (20), preferably ± 10 degree perpendicular to the extension of the biplane blade (20).

17. The blade assembly (1) according to any of the previous claims, wherein a chord line of the biplane airfoil (26) of the biplane blade (20) is smaller than a chord line of the primary airfoil (16) of the primary blade (10).

18. The blade assembly (1) according to claim 17, wherein the chord line of the biplane airfoil (26) of the biplane blade (20) is in an interval of 10 – 50 % of the chord line of the primary airfoil (16) of the primary blade (10), preferably 20 – 30 % of the chord line of the primary airfoil (16) of the primary blade (10).

19. The blade assembly (1) according to any of claim 12-18, wherein the secondary strut (40) comprises at least one beam that is arranged streamlined in respect to a direction of displacement of the blade assembly (1).

20. The blade assembly (1) according to any of claim 12-19, wherein the secondary strut (40) comprises two or more beams connected extending between different locations of the primary blade (10) and the biplane blade (20).

21. The blade assembly (1) according to any of the previous claims, wherein the primary attachment part (12) of the primary blade (10) comprises two attachment

portions (13a, 13b) separated from each other, wherein the two attachment portions (13a, 13b) are configured to form an attachment to the mast (5).

22. The blade assembly (1) according to any of the previous claims, wherein a
5 connection part of the primary strut (30) comprises two attachment portions (23a, 23b) separated from each other, wherein the two attachment portions (23a, 23b) are configured to form an attachment to the mast (5).

23. The blade assembly (1) according to any of the previous claims, wherein the
10 primary blade (10) and the biplane blade (20) mainly comprises one of aluminum and wood, or a combination thereof.

24. The blade assembly (1) according to any of the previous claims, wherein a tip
15 portion (14) of the primary blade (10) comprises a leading edge comprising a layer of one of steel, titanium and aluminum, or a combination thereof.

25. The blade assembly (1) according to any of the previous claims, wherein at least
one of the primary blade (10) and the biplane blade (20) comprises a beam
assembly (50), preferably a box beam assembly, and an aerodynamic shell (52)
20 fixed to the beam assembly (50).

26. The blade assembly (1) according to claim 24, wherein the aerodynamic shell
comprises a core (60) and an inner layer (62) and outer layer (64) attached to the
core (60), wherein the core (60) mainly comprising one of a biological derived
25 composition, preferably wood, a honeycomb structure of para-aramid synthetic fiber composition or aluminum, a metal foam and a polymer foam, preferably mainly comprising divinycells, wherein the inner layer (62) and the outer layer (64) mainly comprises a sheet of an aluminum alloy.

30 27. The blade assembly (1) according to any of claim 24-26, wherein the core (60), the inner layer (62) and the outer layer (64) are bound together with an adhesive, preferably epoxy.

28. The blade assembly (1) according to any of claim 25-27, wherein a sheet of an
35 aluminum alloy of the inner layer (62) and the outer layer (64) have been joined by means of friction-stir-welding.

29. The blade assembly (1) according to any of claim 25-28, wherein the beam assembly (50) comprises a beam mainly comprising an aluminum alloy.
30. The blade assembly (1) according to any of claim 12-29, wherein the primary blade (10), the biplane blade (20), the primary strut (30) and the secondary strut (40) are made of separate elements.
31. The blade assembly (1) according to any of claim 24-30, wherein the beam assembly (50) of the primary blade (10) and the biplane blade (20) have been joined together by means of friction stir welding.
32. The blade assembly (1) according to any of the previous claims, wherein at least one of the primary blade (10) and the biplane blade (20) comprises a leading edge along its extension, wherein the leading edge comprises a layer of one of steel, titanium and aluminum, or a combination thereof.
33. The blade assembly (1) according to any of the previous claims, wherein the blade assembly (1) comprises pin joints (70) configured to hold the primary blade (10), the biplane blade (20), the primary strut (30) and the secondary strut (40) rotatably attached at their respective attachment during assembling the blade assembly (1).
34. The blade assembly (1) according to claim 33, wherein the blade assembly (1) comprises locking means configured to lock the pin joints (70) from rotation after completion of assembling the blade assembly (1).
35. A mast (5) of a wind-power plant comprising a blade assembly (1) according to any of claim 1-34.
36. Use of a blade assembly (1) according to any of claim 1-34.