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Blade and rotor

Abstract

A blade for use in a rotor of an aircraft is swept in a region extending to a blade tip from a first position located between the rotation center of the rotor and the blade tip in a radial direction of the VTOL rotor, the sweep amount increases from the first position toward the blade tip, and the rate of change of the sweep amount in a region extending to the blade tip from a second position located between the first position and the blade tip in the radial direction of the VTOL rotor, is greater than the rate of change of the sweep amount in a region extending from the first position to the second position.

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Background/Summary

CROSS-REFERENCE TO RELATED APPLICATIONS
(1) This application is based upon and claims the benefit of priority from Japanese Patent Application No. 2022-158046 filed on Sep. 30, 2022, the contents of which are incorporated herein by reference.
BACKGROUND OF THE INVENTION

Field of the Invention
(2) The present invention relates to a blade and a rotor.
DESCRIPTION OF THE RELATED ART
(3) U.S. Pat. No. 10,899,440 B2 discloses the shape of the rotor blade of a helicopter.
SUMMARY OF THE INVENTION
(4) In the technique disclosed in U.S. Pat. No. 10,899,440 B2, the blade has a sweep angle. Noise can be reduced by providing the sweep angle. However, U.S. Pat. No. 10,899,440 B2 does not consider the energy efficiency of the blade. Therefore, there is room for improvement in the structure of the blade that achieves both improvement in noise and improvement in energy efficiency.
(5) An object of the present invention is to solve the above-mentioned problem.
(6) According to a first aspect of the present invention, there is provided a blade for use in a rotor of an aircraft, wherein the blade is swept in a region of the blade extending to a blade tip from a first position located between a rotation center of the rotor and the blade tip in a radial direction of the rotor, an amount of sweep of the blade increases from the first position toward the blade tip, and a rate of change of the amount of sweep in a region of the blade extending to the blade tip from a second position located between the first position and the blade tip in the radial direction of the rotor is greater than a rate of change of the amount of sweep in a region of the blade extending from the first position to the second position.
(7) According to a second aspect of the present invention, there is provided a rotor comprising the blade according to the first aspect, wherein the blade comprises three or more blades.
(8) According to the present invention, it is possible to provide a blade having a sweep angle set in consideration of noise and energy efficiency, and a rotor including the blade.
(9) The above and other objects, features, and advantages of the present invention will become more apparent from the following description when taken in conjunction with the accompanying drawings, in which a preferred embodiment of the present invention is shown by way of illustrative example.

Description

BRIEF DESCRIPTION OF THE DRAWINGS
(1) FIG. **1** is a schematic diagram of an aircraft;
(2) FIG. **2** is a diagram showing a blade;
(3) FIG. **3** is a graph showing a sweep amount of the blade with respect to the position on the blade in a longitudinal direction thereof;
(4) FIG. **4** is a graph showing a twist angle of the blade with respect to the position on the blade in the longitudinal direction;
(5) FIG. **5** is a diagram showing a simulation result of energy efficiency in a case where a position at which a sweep angle increases in a blade tip section is changed;
(6) FIG. **6** is a diagram showing a simulation result of energy efficiency in a case where a position at which the twist of the blade decreases is changed; and
(7) FIG. **7** is a diagram showing a simulation result of energy efficiency in a case where a position at which the blade starts to be swept is changed.
DETAILED DESCRIPTION OF THE INVENTION
First Embodiment
Configuration of Aircraft
(8) FIG. **1** is a schematic view of an aircraft **10**. The aircraft **10** of the present embodiment is an electric vertical take-off and landing aircraft (eVTOL aircraft). The aircraft **10** of the present embodiment includes a plurality of VTOL rotors **12** and a plurality of cruise rotors **14**. Rotation of

the VTOL rotors **12** generates lift for moving a fuselage **16** upward. Rotation of the cruise rotors **14** generates thrust for moving the fuselage **16** forward.
(9) The aircraft **10** includes the fuselage **16**. The fuselage **16** is provided with a cockpit, a cabin, and the like. A pilot rides in the cockpit and controls the aircraft **10**. Passengers and the like ride in the cabin. The aircraft **10** may be automatically controlled without a pilot aboard.
(10) The aircraft **10** includes a front wing **18** and a rear wing **20**, which are fixed wings. The front wing **18** is provided forward of a center of gravity G of the fuselage **16**. The rear wing **20** is provided rearward of the center of gravity G of the fuselage **16**. In a case where the fuselage **16** has an airspeed, lift is generated in the front wing **18** and the rear wing **20** by controlling the angles of attack of the front wing **18** and the rear wing **20**.
(11) The aircraft **10** includes eight VTOL rotors **12**. The eight VTOL rotors **12** are a rotor **12**FLa, a rotor **12**FLb, a rotor **12**RLa, a rotor **12**RLb, a rotor **12**FRa, a rotor **12**FRb, a rotor **12**RRa, and a rotor **12**RRb. Each of the VTOL rotors **12** corresponds to a rotor of the present invention.
(12) The rotor **12**FLa, the rotor **12**FLb, the rotor **12**RLa, and the rotor **12**RLb are attached to a boom **22**L. The boom **22**L extends in the front-rear direction. The rotor **12**FLa, the rotor **12**FLb, the rotor **12**RLa, and the rotor **12**RLb are lined up in the front-rear direction of the fuselage **16** of the aircraft **10**. The boom **22**L is attached to the front wing **18** and the rear wing **20**. The boom **22**L is provided on the left side of the center of gravity G. That is, the rotor **12**FLa, the rotor **12**FLb, the rotor **12**RLa, and the rotor **12**RLb are disposed on the left side of the center of gravity G.
(13) The rotor **12**FLa is provided forward of the front wing **18**. The rotor **12**FLb is provided between the front wing **18** and the center of gravity G in the front-rear direction of the fuselage **16**. The rotor **12**RLb is provided between the center of gravity G and the rear wing **20** in the front-rear direction of the fuselage **16**. The rotor **12**RLa is provided rearward of the rear wing **20**. The distance from the center of gravity G to the rotor **12**FLb is shorter than the distance from the center of gravity G to the rotor **12**FLa. The distance from the center of gravity G to the rotor **12**RLb is shorter than the distance from the center of gravity G to the rotor **12**RLa.
(14) The rotor **12**FRa, the rotor **12**FRb, the rotor **12**RRa, and the rotor **12**RRb are attached to a boom **22**R. The boom **22**R extends in the front-rear direction. The rotor **12**FRa, the rotor **12**FRb, the rotor **12**RRa, and the rotor **12**RRb are lined up in the front-rear direction of the fuselage **16** of the aircraft **10**. The boom **22**R is attached to the front wing **18** and the rear wing **20**. The boom **22**R is provided on the right side of the center of gravity G. That is, the rotor **12**FRa, the rotor **12**FRb, the rotor **12**RRa, and the rotor **12**RRb are disposed on the right side of the center of gravity G.
(15) The rotor **12**FRa is provided forward of the front wing **18**. The rotor **12**FRb is provided between the front wing **18** and the center of gravity G in the front-rear direction of the fuselage **16**. The rotor **12**RRb is provided between the center of gravity G and the rear wing **20** in the front-rear direction of the fuselage **16**. The rotor **12**RRa is provided rearward of the rear wing **20**. The distance from the center of gravity G to the rotor **12**FRb is shorter than the distance from the center of gravity G to the rotor **12**FRa. The distance from the center of gravity G to the rotor **12**RRb is shorter than the distance from the center of gravity G to the rotor **12**RRa.
(16) In FIG. **1**, the boom **22**L and the boom **22**R have a shape linearly extending in the front-rear direction of the fuselage **16**. However, the boom **22**L and the boom **22**R may be formed in an arc shape protruding outward in the left-right direction of the fuselage **16**. When the boom **22**L is formed in an arc shape protruding outward in the left-right direction of the fuselage **16**, the rotor **12**FLb is located on the left side (outer side) of the rotor **12**FLa in the left-right direction of the fuselage **16**. When the boom **22**R is formed in an arc shape protruding outward in the left-right direction of the fuselage **16**, the rotor **12**FRb is located on the right side (outer side) of the rotor **12**FRa in the left-right direction of the fuselage **16**.
(17) Each VTOL rotor **12** includes a rotation shaft **24**. The rotation shaft **24** extends in the up-down direction of the fuselage **16**. The rotation shaft **24** may be angled (canted) a few degrees with respect to the up-down direction of the fuselage **16**.

(18) Each VTOL rotor **12** includes three blades **26**. Each VTOL rotor **12** may include more than three blades **26**.
(19) When the VTOL rotor **12** rotates about the rotation shaft **24**, lift is generated in the blades **26**. The magnitude of the lift generated by the VTOL rotor **12** is controlled by controlling the rotational speed of the VTOL rotor **12** and the pitch of the blades **26**. The VTOL rotor **12** rotates and generates lift mainly during vertical take-off, during transition from vertical take-off to cruising, during transition from cruising to vertical landing, during vertical landing, during hovering, and the like. On the other hand, in a state where lift is generated in the front wing **18** and the rear wing **20** during cruising or the like, the rotation of the VTOL rotor **12** is stopped.
(20) The aircraft **10** includes two cruise rotors **14**. The two cruise rotors **14** are a rotor **14**L and a rotor **14**R.
(21) The rotor **14**L and the rotor **14**R are attached to a rear portion of the fuselage **16**. The rotor **14**L is disposed on the left side of a center line A of the fuselage **16**. The rotor **14**R is disposed on the right side of the center line A of the fuselage **16**.
(22) A rotation shaft (not shown) of each cruise rotor **14** extends in the front-rear direction of the fuselage **16**. The rotation shaft of each cruise rotor **14** may be angled (canted) a few degrees with respect to the front-rear direction. Each cruise rotor **14** includes a plurality of blades (not shown).
(23) When the cruise rotor **14** rotates about the rotation shaft, thrust is generated in the blades. The magnitude of the thrust of the cruise rotor **14** is controlled by controlling the rotational speed thereof and the pitch of the blades. The cruise rotor **14** rotates and generates thrust mainly during transition from vertical take-off to cruising, during cruising, during transition from cruising to vertical landing, and the like.
Shape of Blade
(24) FIG. **2** is a diagram showing the blade **26**. In the present embodiment, the position on the blade **26** in the longitudinal direction thereof is indicated by % R. % R represents the ratio of the length of the blade **26** from a rotation center of the VTOL rotor **12** to the position, to a length R which is the length of the blade **26** from the rotation center to a blade tip. It is assumed that the position of the rotation center of the VTOL rotor **12** is 0% R and the position of the blade tip is 100% R. The longitudinal direction of the blade **26** coincides with a radial direction of the VTOL rotor **12**. Hereinafter, the rotation center of the VTOL rotor **12** may be simply referred to as a rotation center.
(25) A blade root section **30** provided to extend from the rotation center (0% R) to 15% R has an elliptical cross-section. In the aircraft **10** according to the present embodiment, the rotation of the VTOL rotor **12** is stopped during cruising or the like. Therefore, when the rotation is stopped, it is required to reduce the air resistance of the blade **26**. In addition, the blade root section **30** contributes less than the other sections to the generation of lift during the rotation. Therefore, by forming the cross-section of the blade root section **30** into an elliptical shape, the air resistance when the rotation of the VTOL rotor **12** is stopped is reduced while suppressing a decrease in the energy efficiency when the VTOL rotor **12** rotates.
(26) A blade section **32** is provided closer to the blade tip (100% R) than the blade root section **30** is. The blade section **32** is provided to extend at least from the position of 50% R of the blade **26** to the blade tip (100% R). The blade section **32** may be provided closer to the rotation center (0% R) than the position of 50% R. The blade section **32** has a thin plate-shaped cross-section. A connecting section **34** is provided between the blade root section **30** and the blade section **32**. The connecting section **34** is formed in a shape that smoothly connects the blade root section **30** and the blade section **32**.
(27) The blade **26** is swept from 70% R to the blade tip (100% R). Hereinafter, the position of 70% R at which the blade **26** starts to be swept may be referred to as a first position. The first position at which the blade **26** is swept is not limited to the position of 70% R but may be any position between 65% R and 75% R. In addition, the twist angle of the blade section **32** of the blade **26**

changes at least from the position of 50% R toward the blade tip (100% R). In the blade **26**, the twist angle of the entire blade section **32** may change toward the radially outer side of the VTOL rotor **12**.

(28) FIG. **3** is a graph showing a sweep amount of the blade **26** with respect to the position on the blade **26** in the longitudinal direction. The sweep amount of the blade **26** increases from the first position (70% R) toward the blade tip (100% R).

(29) The rate of change of the sweep amount in the region from 95% R to the blade tip (100% R) is greater than the rate of change of the sweep amount in the region from the first position (70% R) to 95% R. In other words, the sweep angle in the region from 95% R to the blade tip (100% R) is greater than the sweep angle in the region from the first position (70% R) to 95% R. Hereinafter, the position of 95% R at which the rate of change of the sweep amount changes may be referred to as a second position. The second position at which the rate of change of the sweep amount changes is not limited to 95% R but may be in a range from 92.5% R to 97.5% R.

(30) The blade **26** is swept from the first position to the blade tip. As a result, the timing at which the blade tip vortex generated by a blade **26** having passed before collides with the blade section **32** is shifted. As a result, energy loss (aerodynamic loss) and noise at the blade tip section having a high degree of contribution to energy efficiency are reduced while suppressing loss associated with a change in the sweep angle.

(31) The sweep angle of the blade **26** further increases from the second position to the blade tip. As a result, the generation of the blade tip vortex is reduced.

(32) FIG. **4** is a graph showing a twist angle of the blade **26** with respect to the position on the blade **26** in the longitudinal direction. The twist angle of the blade **26** decreases from 35% R toward the blade tip (100% R).

(33) The rate of change of the twist angle at least in the region from 50% R to 80% R is smaller than the rate of change of the twist angle in the region from 80% R to 95% R. The rate of change of the twist angle in the region from 35% R to 80% R may be smaller than the rate of change of the twist angle in the region from 80% R to 95% R. Hereinafter, the position of 50% R may be referred to as a third position. The position of 80% R at which the rate of change of the twist angle of the blade **26** changes may be referred to as a fourth position. The fourth position at which the rate of change of the twist angle of the blade **26** changes is not limited to the position of 80% R but may be in a range from 75% R to 85% R.

(34) The rate of change of the twist angle in the region from the fourth position (80% R) to 95% R is greater than the rate of change of the twist angle in the region from 95% R to the blade tip (100% R). Hereinafter, the position of 95% R at which the rate of change of the twist angle of the blade **26** changes may be referred to as a fifth position. The fifth position is the same as the second position at which the rate of change of the sweep amount of the blade **26** changes. The fifth position and the second position may be slightly shifted from each other. In addition, the fifth position at which the rate of change of the twist angle of the blade **26** changes is not limited to the position of 95% R, but may be in a range from 92.5% R to 97.5% R.

(35) The twist of the blade **26** increases from the fourth position to the fifth position, and decreases from the fifth position to the blade tip. As a result, the influence of the blade tip vortex generated from the blade **26** on a blade **26** passing next is reduced. This improves the energy efficiency of the VTOL rotor **12**.

(36) As shown in FIG. **2**, the distance between the rotation center (0% R) and the fourth position (80% R) is longer than the distance between the fourth position (80% R) and the blade tip (100% R). The distance between the fourth position (80% R) and the blade tip (100% R) is longer than the distance between the fifth position (95% R) and the blade tip (100% R). The distance between the rotation center (0% R) and the fourth position (80% R) is longer than the distance between the fourth position (80% R) and the blade tip (100% R). The distance between the fourth position (80% R) and the blade tip (100% R) is longer than the distance between the fifth position (95% R) and

the blade tip (100% R). The distance between the rotation center (0% R) and the first position (70% R) is shorter than the distance between the rotation center (0% R) and the fourth position (80% R). The distance between the rotation center (0% R) and the first position (70% R) is longer than the distance between the first position (70% R) and the blade tip (100% R).

Advantageous Effects

(37) The blade **26** of the present embodiment is swept in the region from the first position (70% R), which is a position between the center of rotation and the blade tip in the radial direction of the VTOL rotor **12**, to the blade tip (100% R). In the blade **26**, the sweep angle in the region from the second position (95% R) to the blade tip (100% R) is greater than the sweep angle in the region from the first position (70% R) to the second position (95% R). That is, the sweep angle of the blade **26** of the present embodiment increases in the blade tip section.

(38) FIG. **5** is a diagram showing a simulation result of energy efficiency in a case where a position (the second position) at which the sweep angle increases is changed in the blade tip section. The solid line indicates the sweep amount with respect to the position on the blade **26** in the longitudinal direction in a case where the sweep angle increases at 95% R as in the present embodiment. The dotted line indicates the sweep amount with respect to the position on the blade **26** in the longitudinal direction in a case where the sweep angle does not increase in the blade tip section. The alternate long and short dash line indicates the sweep amount with respect to the position on the blade **26** in the longitudinal direction in a case where the sweep angle increases at 90% R.

(39) The numbers in the square frames in FIG. **5** each indicate the energy efficiency when the energy efficiency of the VTOL rotor **12** obtained using the blade **26** of the present embodiment is set to “1.000”.

(40) As shown in FIG. **5**, the energy efficiency in the case where the sweep angle increases in the blade tip section (the solid line, the alternate long and short dash line) becomes higher than the energy efficiency in the case where the sweep angle does not increase in the blade tip section (the dotted line). That is, by increasing the sweep angle of the blade tip section of the blade **26**, the energy efficiency of the VTOL rotor **12** can be improved.

(41) In the blade **26** of the present embodiment, the twist increases at the fourth position (80% R) and the twist decreases at the fifth position (95% R). The fifth position (95% R) is substantially the same position as the second position (95% R) at which the sweep angle increases in the blade tip section.

(42) FIG. **6** is a diagram showing a simulation result of energy efficiency in a case where a position (the fifth position) at which the twist of the blade **26** decreases is changed. The solid line indicates the twist angle of the blade **26** with respect to the position on the blade **26** in the longitudinal direction in a case where the twist of the blade **26** decreases at 95% R as in the present embodiment. The dotted line indicates the twist angle of the blade **26** with respect to the position on the blade **26** in the longitudinal direction in a case where the twist of the blade **26** does not decrease in the blade tip section. The alternate long and short dash line indicates the twist angle of the blade **26** with respect to the position on the blade **26** in the longitudinal direction in a case where the twist of the blade **26** decreases at 90% R.

(43) The numbers in the square frames in FIG. **6** each indicate the energy efficiency when the energy efficiency of the VTOL rotor **12** obtained using the blade **26** of the present embodiment is set to “1.000”.

(44) As shown in FIG. **6**, the energy efficiency in the case where the twist of the blade **26** decreases at 95% R (the solid line) becomes higher than the energy efficiency in the case where the twist of the blade **26** does not decrease in the blade tip section (the dotted line). Further, the energy efficiency in the case where the twist of the blade **26** decreases at 95% R (the solid line) becomes higher than the energy efficiency in the case where the twist of the blade **26** decreases at 90% R (the alternate long and short dash line). That is, the energy efficiency of the VTOL rotor **12** can be

improved by decreasing the twist of the blade **26** at substantially the same position as the position at which the sweep angle increases in the blade tip section.

(45) In the blade **26** of the present embodiment, the first position (70% R) at which the blade **26** starts to be swept is located closer to the rotation center (0% R) than is the fourth position (80% R) at which the twist of the blade **26** increases.

(46) FIG. **7** is a diagram showing a simulation result of energy efficiency in a case where a position (the first position) at which the blade **26** starts to be swept is changed. The solid line indicates the sweep amount of the blade **26** with respect to the position on the blade **26** in the longitudinal direction in a case where the blade **26** starts to be swept at 70% R as in the present embodiment. The dotted line indicates the sweep amount of the blade **26** with respect to the position on the blade **26** in the longitudinal direction in a case where the blade **26** starts to be swept at 80% R which is the same as the fourth position. The alternate long and short dash line indicates the sweep amount of the blade **26** with respect to the position on the blade **26** in the longitudinal direction in a case where the blade **26** starts to be swept at 60% R.

(47) The numbers in the square frames in FIG. **7** each indicate the energy efficiency when the energy efficiency of the VTOL rotor **12** obtained using the blade **26** of the present embodiment is set to “1.000”.

(48) As shown in FIG. **7**, the energy efficiency in the case where the blade **26** starts to be swept at the position closer to the rotation center (0% R) than is the fourth position (80% R) (the solid line, the alternate long and short dash line) becomes higher than the energy efficiency in the case where the blade **26** starts to be swept at the same position as the fourth position (the dotted line). That is, the energy efficiency of the VTOL rotor **12** can be improved by the first position (70% R) at which the blade **26** starts to be swept being located closer to the rotation center (0% R) than is the fourth position (80% R) at which the twist of the blade **26** increases.

Invention Obtained from Embodiment

(49) The inventions that can be grasped from the above embodiment will be described below.

(50) Provided is the blade (**26**) for use in the rotor (**12**) of the aircraft (**10**), wherein the blade is swept in a region of the blade extending to a blade tip from a first position located between a rotation center of the rotor and the blade tip in a radial direction of the rotor, an amount of sweep of the blade increases from the first position toward the blade tip, and a rate of change of the amount of sweep in a region of the blade extending to the blade tip from a second position located between the first position and the blade tip in the radial direction of the rotor is greater than a rate of change of the amount of sweep in a region of the blade extending from the first position to the second position. According to this feature, the energy efficiency of the rotor can be improved.

(51) In the above blade, a twist angle of the blade may change at least from a third position toward the blade tip, the third position being located at a center between the rotation center of the rotor and the blade tip in the radial direction of the rotor, a rate of change of the twist angle in a region of the blade extending from a fourth position located between the rotation center of the rotor and the blade tip in the radial direction of the rotor, to a fifth position located between the rotation center of the rotor and the blade tip in the radial direction of the rotor, may be greater than a rate of change of the twist angle in a region of the blade extending from the fifth position to the blade tip, a distance between the rotation center of the rotor and the fourth position may be longer than a distance between the fourth position and the blade tip, the distance between the fourth position and the blade tip may be longer than a distance between the fifth position and the blade tip, and the fifth position may be substantially a same position as the second position. According to this feature, the energy efficiency of the rotor can be improved.

(52) In the above blade, a twist angle of the blade may change at least from a third position toward the blade tip, the third position being located at a center between the rotation center of the rotor and the blade tip in the radial direction of the rotor, a rate of change of the twist angle in a region of the blade extending from the third position to a fourth position located between the rotation center of

the rotor and the blade tip in the radial direction of the rotor, may be smaller than a rate of change of the twist angle in a region of the blade extending from the fourth position to a fifth position located between the rotation center of the rotor and the blade tip in the radial direction of the rotor, a distance between the rotation center of the rotor and the fourth position may be longer than a distance between the fourth position and the blade tip, the distance between the fourth position and the blade tip may be longer than a distance between the fifth position and the blade tip, and a distance between the rotation center of the rotor and the first position may be shorter than the distance between the rotation center of the rotor and the fourth position. According to this feature, the energy efficiency of the rotor can be improved.
(53) In the above blade, a distance between the rotation center of the rotor and the first position may be longer than a distance between the first position and the blade tip. According to this feature, the energy efficiency of the rotor can be improved.
(54) The rotor includes the above blade, and the blade comprises three or more blades. According to this feature, the energy efficiency of the rotor can be improved.
(55) The rotor including the above blade may be provided in plurality and the plurality of rotors may be lined up in a front-rear direction of the fuselage (**16**) of the aircraft. According to this feature, the energy efficiency of the rotor can be improved.
(56) According to the above rotor, the aircraft may include the fixed wing configured to generate lift, and rotation of the rotors may be stopped in a state where the lift is generated in the fixed wing. According to this feature, the energy efficiency of the rotor can be improved.
(57) Note that the present invention is not limited to the above disclosure, and various modifications are possible without departing from the essence and gist of the present invention.

Claims

1. A blade for use in a rotor of an aircraft, wherein the blade is swept in a region of the blade extending to a blade tip from a first position located between a rotation center of the rotor and the blade tip in a radial direction of the rotor, an amount of sweep of the blade increases from the first position toward the blade tip, a rate of change of the amount of sweep in a region of the blade extending to the blade tip from a second position located between the first position and the blade tip in the radial direction of the rotor is greater than a rate of change of the amount of sweep in a region of the blade extending from the first position to the second position, a twist angle of the blade continuously changes at least from a third position to the blade tip, the third position being located at a center between the rotation center of the rotor and the blade tip in the radial direction of the rotor, a rate of change of the twist angle in a region of the blade extending from a fourth position located between the rotation center of the rotor and the blade tip in the radial direction of the rotor, to a fifth position located between the rotation center of the rotor and the blade tip in the radial direction of the rotor, is greater than a rate of change of the twist angle in a region of the blade extending from the fifth position to the blade tip, a distance between the rotation center of the rotor and the fourth position is longer than a distance between the fourth position and the blade tip, the distance between the fourth position and the blade tip is longer than a distance between the fifth position and the blade tip, and the fifth position is a same position as the second position.
2. The blade according to claim 1, wherein a rate of change of the twist angle in a region of the blade extending from the third position to the fourth position is smaller than the rate of change of the twist angle in the region of the blade extending from the fourth position to the fifth position, and a distance between the rotation center of the rotor and the first position is shorter than the distance between the rotation center of the rotor and the fourth position.
3. The blade according to claim 1, wherein a distance between the rotation center of the rotor and the first position is longer than a distance between the first position and the blade tip.
4. The blade according to claim 1, wherein the blade has no forward-swept portion in a region from

the rotation center of the rotor to the wing tip.
5. The blade according to claim 1, wherein a distance between the rotation center of the rotor and the first position is shorter than the distance between the rotation center of the rotor and the fourth position.
6. A rotor comprising the blade according to claim 1, wherein the blade is one of three or more blades.
7. An aircraft comprising a plurality of rotors, each of the rotors including the blade according to claim 1, wherein the plurality of rotors are lined up in a front-rear direction of a fuselage of the aircraft.
8. The aircraft according to claim 7, wherein the aircraft includes a fixed wing configured to generate lift, and rotation of the plurality of rotors is stopped in a state where the lift is generated in the fixed wing.
9. A blade for use in a rotor of an aircraft, wherein the blade is swept in a region of the blade extending to a blade tip from a first position located between a rotation center of the rotor and the blade tip in a radial direction of the rotor, an amount of sweep of the blade increases from the first position toward the blade tip, a rate of change of the amount of sweep in a region of the blade extending to the blade tip from a second position located between the first position and the blade tip in the radial direction of the rotor is greater than a rate of change of the amount of sweep in a region of the blade extending from the first position to the second position, a twist angle of the blade changes at least from a third position toward the blade tip, the third position being located at a center between the rotation center of the rotor and the blade tip in the radial direction of the rotor, a rate of change of the twist angle in a region of the blade extending from a fourth position located between the rotation center of the rotor and the blade tip in the radial direction of the rotor, to a fifth position located between the rotation center of the rotor and the blade tip in the radial direction of the rotor, is greater than a rate of change of the twist angle in a region of the blade extending from the fifth position to the blade tip, a distance between the rotation center of the rotor and the fourth position is longer than a distance between the fourth position and the blade tip, the distance between the fourth position and the blade tip is longer than a distance between the fifth position and the blade tip, the fifth position is a same position as the second position, and the blade has no forward-swept portion in a region from the rotation center of the rotor to the wing tip.
10. A blade for use in a rotor of an aircraft, wherein the blade is swept in a region of the blade extending to a blade tip from a first position located between a rotation center of the rotor and the blade tip in a radial direction of the rotor, an amount of sweep of the blade increases from the first position toward the blade tip, a rate of change of the amount of sweep in a region of the blade extending to the blade tip from a second position located between the first position and the blade tip in the radial direction of the rotor is greater than a rate of change of the amount of sweep in a region of the blade extending from the first position to the second position, a twist angle of the blade changes at least from a third position toward the blade tip, the third position being located at a center between the rotation center of the rotor and the blade tip in the radial direction of the rotor, a rate of change of the twist angle in a region of the blade extending from a fourth position located between the rotation center of the rotor and the blade tip in the radial direction of the rotor, to a fifth position located between the rotation center of the rotor and the blade tip in the radial direction of the rotor, is greater than a rate of change of the twist angle in a region of the blade extending from the fifth position to the blade tip, a distance between the rotation center of the rotor and the fourth position is longer than a distance between the fourth position and the blade tip, the distance between the fourth position and the blade tip is longer than a distance between the fifth position and the blade tip, the fifth position is a same position as the second position, and a distance between the rotation center of the rotor and the first position is shorter than the distance between the rotation center of the rotor and the fourth position.