Claims

1. A lattice structure which is mounted on a work machine, and is detachably coupled to a counterpart lattice structure adjacent to the lattice structure, the lattice structure comprising:

four main pipes arranged at an interval in a radial direction;

a plurality of inclined pipes extending so as to be inclined with respect to an axial direction of each of the four main pipes, each of the plurality of inclined pipes coupling any two of the four main pipes to each other; and

a plurality of connectors detachably coupled to a plurality of counterpart connectors included in the counterpart lattice structure,

wherein the plurality of connectors include a predetermined connector to which an end portion of any one of the four main pipes is connected, and to which an end portion of at least one of the plurality of inclined pipes is connected,

an angle formed by a center axis line of the main pipe which is connected to the predetermined connector and a center axis line of the inclined pipe which is connected to the predetermined connector is set to an acute angle,

the work machine is a crane, and

the lattice structure forms a portion of a boom or a jib of the crane.

2. The lattice structure according to claim 1, wherein

the plurality of connectors each have a pin insertion hole into which a coupling pin for coupling the connector to the corresponding counterpart connector is inserted, and

a position of a portion of the predetermined connector to which the main pipe is connected and a position of a portion of the predetermined connector to which the inclined pipe is connected are respectively set such that center lines of the plurality of pin insertion holes in the plurality of connectors are parallel to each other.

3. The lattice structure according to claim 2, wherein

the predetermined connector is a first connector which has a main pipe connecting portion to which an end portion of a first main pipe among the four main pipes is connected, and an inclined pipe connecting portion to which an end portion of a first inclined pipe among the plurality of inclined pipes is connected,

the plurality of connectors further include a second connector which has a main pipe connecting portion to which an end portion of a second main pipe among the four main pipes is connected, and an inclined pipe connecting portion to which an end portion of a second inclined pipe among the plurality of inclined pipes is connected, and

a first plane parallel to a direction in which the first main pipe extends and a direction in which the first inclined pipe extends intersects with a second plane parallel to a direction in which the second main pipe extends and a direction in which the second inclined pipe extends, and a relative position of the inclined pipe connecting portion with respect to the main pipe connecting portion is set in the first connector and a relative position of the inclined pipe connecting portion with respect to the main pipe connecting portion is set in the second connector such that a center line of the pin insertion hole in the first connector is parallel to a center line of the pin insertion hole in the second connector.

4. The lattice structure according to claim 1, wherein

the predetermined connector includes:

a first connecting portion to which the inclined pipe extending in a first inclined direction among the plurality of inclined pipes is connected; and

a second connecting portion to which the inclined pipe extending in a second inclined direction among the plurality of inclined pipes is connected.

5. The lattice structure according to claim 4, wherein

a relative position between the first connecting portion and the second connecting portion is set such that a plane parallel to a main direction which is a direction in which the main pipe connected to the predetermined connector extends and the first inclined direction intersects with a plane parallel to the main direction and the second inclined direction.

6. The lattice structure according to claim 4 or 5, wherein

all of a center axis line of the main pipe connected to the predetermined connector, a center axis line of the inclined pipe connected to the first connecting portion, and a center axis line of the inclined pipe connected to the second connecting portion pass through a region surrounded by a profile of the predetermined connector.

7. The lattice structure according to claim 4 or 5, wherein

the predetermined connector has a pin insertion hole into which a coupling pin is inserted, and is configured such that the predetermined connector is connected to the counterpart connector by inserting the coupling pin into the pin insertion hole and a pin insertion hole formed in the counterpart connector which corresponds to the predetermined connector, and

all of a center axis line of the main pipe connected to the predetermined connector, a center axis line of the inclined pipe connected to the first connecting portion, and a center axis line of an inclined pipe connected to the second connecting portion pass through at least one of a region surrounded by an inner peripheral surface which defines the pin

insertion hole of the predetermined connector and a region surrounded by an inner peripheral surface which defines the pin insertion hole of the counterpart connector.

8. The lattice structure according to claim 4 or 5, wherein

both of a center axis line of the inclined pipe connected to the first connecting portion and a center axis line of the inclined pipe connected to the second connecting portion pass through an overlapping region which is a region where at least one of a region surrounded by a profile of the predetermined connector and a region surrounded by a profile of the counterpart connector which corresponds to the predetermined connector overlaps with a region surrounded by an imaginary plane where an outer peripheral surface of the main pipe connected to the predetermined connector extends in a direction in which the main pipe extends.

9. A lattice structure coupling body comprising:

the lattice structure according to any one of claims 1 to 8; and

the counterpart lattice structure,

wherein the counterpart lattice structure further includes:

four counterpart main pipes arranged at an interval in a radial direction; and

a plurality of counterpart inclined pipes extending so as to be inclined with respect to an axial direction of each of the four counterpart main pipes, each of the plurality of counterpart inclined pipes coupling any two of the four counterpart main pipes to each other, and

the plurality of counterpart connectors include a predetermined counterpart connector to which an end portion of any one of the four counterpart main pipes is connected, and to which an end portion of at least one of the plurality of counterpart inclined pipes is connected, the predetermined counterpart connector being detachably coupled to the predetermined connector.

10. The lattice structure coupling body according to claim 9, wherein

as viewed in a side view of the predetermined connector, a center axis line of the main pipe connected to the predetermined connector and a center axis line of at least one inclined pipe connected to the predetermined connector intersect with each other within a range of the predetermined connector, and

as viewed in a side view of the predetermined counterpart connector, a center axis line of the counterpart main pipe connected to the predetermined counterpart connector and a center axis line of at least one counterpart inclined pipe connected to the predetermined counterpart connector intersect with each other within a range of the predetermined counterpart connector.

11. The lattice structure coupling body according to claim 9 or 10, wherein

the predetermined connector and the predetermined counterpart connector each have a pin insertion hole into which a coupling pin is inserted, and are configured such that the predetermined connector and the predetermined counterpart connector are coupled to each other by inserting the coupling pin into the pin insertion holes,

in a state where the predetermined connector is viewed in an axial direction of the coupling pin, a center axis line of the main pipe connected to the predetermined connector and a center axis line of at least one inclined pipe connected to the predetermined connector intersect with each other within a range of the coupling pin, and

in a state where the predetermined counterpart connector is viewed in the axial direction of the coupling pin, a center axis line of the main pipe connected to the predetermined counterpart connector and a center axis line of the at least one inclined pipe connected to the predetermined counterpart connector intersect with each other within a range of the coupling pin.

12. The lattice structure coupling body according to claim 11, wherein

in a state where the predetermined connector is viewed in an axial direction of the coupling pin, the center axis line of the main pipe connected to the predetermined connector and the center axis line of the at least one inclined pipe connected to the predetermined connector intersect with each other at a center of the coupling pin, and

in a state where the predetermined counterpart connector is viewed in the axial direction of the coupling pin, the center axis line of the main pipe connected to the predetermined counterpart connector and the center axis line of the at least one inclined pipe connected to the predetermined counterpart connector intersect with each other at the center of the coupling pin.

13. A work machine comprising:

a base body;

an upper slewing body slewably mounted on the base body; and

a boom swingably mounted on the upper slewing body, the boom having the lattice structure coupling body according to any one of claims 9 to 12.

14. A connector used for a work machine and forming an end portion of a lattice structure which includes: four main pipes arranged at an interval in a radial direction; and a plurality of inclined pipes extending so as to be inclined with respect to an axial direction of each of the four main pipes, each of the plurality of inclined pipes coupling any two of the four main pipes to each other, the connector being detachably

coupled to a counterpart connector included in a counterpart structure adjacent to the lattice structure, the connector comprising:

a coupling portion for coupling the counterpart connector;

a main pipe connecting portion for connecting an end portion of a predetermined main pipe among the four main pipes; and

an inclined pipe connecting portion for connecting an end portion of at least one of the plurality of inclined pipes, wherein

an angle formed by a center axis line of the main pipe to be connected to the main pipe connecting portion and a center axis line of the inclined pipe to be connected to the inclined pipe connecting portion is set to an acute angle,

the work machine is a crane, and

the lattice structure forms a portion of a boom or a jib of the crane.

15. The connector according to claim 14, wherein

the counterpart structure is a lattice structure, and

the counterpart connector forms an end portion of the counterpart structure, and connects an end portion of a counterpart main pipe which forms the counterpart structure and an end portion of a counterpart inclined pipe to each other.

16. The connector according to claim 14 or 15, wherein

the main pipe connecting portion includes a flat surface which an end surface of the end portion of the predetermined main pipe faces and to which the end portion of the predetermined main pipe is connected, and

the inclined pipe connecting portion includes a flat surface which an end surface of the end portion of the at least one inclined pipe faces and to which the end portion of the at least one inclined pipe is connected.

17. The connector according to claim 14 or 15, wherein

the main pipe connecting portion includes a spherical surface which an end surface of the end portion of the predetermined main pipe faces and to which the end portion of the predetermined main pipe is connected, and

the inclined pipe connecting portion includes a spherical surface which an end surface of the end portion of the at least one inclined pipe faces and to which the end portion of the at least one inclined pipe is connected.

18. The connector according to claim 17, wherein

the coupling portion has a pin insertion hole into which a coupling pin is inserted, and is configured such that the connector and the counterpart connector are coupled to each other by inserting the coupling

pin into the pin insertion hole and a pin insertion hole formed in the counterpart connector, and

in a state where the connector is viewed in an axial direction of the coupling pin, a center of a sphere including the spherical surface of the main pipe connecting portion and a center of a sphere including the spherical surface of the inclined pipe connecting portion are positioned within a range of the coupling pin.

19. The connector according to claim 18, wherein

in a state where the connector is viewed in an axial direction of the coupling pin, the center of the sphere including the spherical surface of the main pipe connecting portion and the center of the sphere including the spherical surface of the inclined pipe connecting portion are positioned at a center of the coupling pin.

20. The connector according to any one of claims 14 to 19, wherein

the main pipe connecting portion includes a projection or a recess for alignment of the position of the end portion of the predetermined main pipe, and

the inclined pipe connecting portion includes a projection or a recess for alignment of the position of the end portion of the at least one inclined pipe.