

RAIL VEHICLE AND METHOD FOR MANUFACTURING RAIL VEHICLE

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present disclosure relates to a rail vehicle and a method for manufacturing a rail vehicle.

2. Description of the Related Art

In general, a railway vehicle operated along a laid track is required to have, for an underframe that forms a floor surface of the vehicle, heat-insulating performance and fire-resistant performance. The heat-insulating performance is performance of preventing entry of heat in the atmosphere in summer in which an outside temperature is high or heat generated by a device placed under the floor into the vehicle via the underframe, and the fire-resistant performance is performance against fire under the floor.

In the related art, in the railway vehicle, heat-insulating materials are constructed at both a vehicle interior side and a vehicle exterior side of the underframe, and a plate-shaped heat-insulating material is disposed below a floor plate on the vehicle exterior side of the underframe in order to further enhance the fire-resistant performance.

JP-A-2009-196531 provides, in a linear motor vehicle

having a small underfloor space, a floor structure of the linear motor vehicle that can provide fire-resistant performance similar to that in the related art without compressing the disposition space of cables, pipes, devices, and the like provided under the floor. JP-A-2009-196531 discloses a technique of disposing a plate-shaped expansion type heat-insulating material below the floor plate in the floor structure of the linear motor vehicle. In the floor structure of the linear motor vehicle, a lower surface of the floor plate is supported by a beam structure that is formed by combining a plurality of beam members extending in a front-rear direction of the vehicle and a plurality of beam members extending in a vehicle width direction.

In general, in the railway vehicle in which the heat-insulating material is constructed at the vehicle interior side of an upper surface of the underframe and fire-resistant performance is provided at a vehicle exterior side surface of the lower surface of the underframe, the heat-insulating material that prevents heat transfer and a heat-shielding plate that enhances fire-resistant performance against fire under the floor are provided, and thus the number of steps of manufacturing the railway vehicle tends to increase.

SUMMARY OF THE INVENTION

In view of the problem in the related art, an object of the disclosure is to provide a rail vehicle including an underframe that ensures heat-insulating performance and fire-resistant performance while reducing the number of manufacturing steps, and a method for manufacturing a rail vehicle.

In order to solve the above problem, one typical rail vehicle according to the disclosure is a rail vehicle including an underframe. The underframe includes a vehicle interior side surface plate, a vehicle exterior side surface plate, and a connecting member that connects the vehicle interior side surface plate and the vehicle exterior side surface plate, and the underframe is formed of a hollow extruded shape member that is extruded and molded along a longitudinal direction of the rail vehicle. The vehicle interior side surface plate includes a plurality of first curtain rail structures including a vertical piece whose lower end portion is connected to the vehicle interior side surface plate, a horizontal piece that extends from an upper end portion of the vertical piece to one side in a horizontal direction, and a section that extends from the vertical piece to the other side in the horizontal direction. The vehicle exterior side surface plate includes a plurality of second curtain rail structures including a vertical piece whose lower end portion is connected to the vehicle exterior

side surface plate and a horizontal piece that extends from an upper end portion of the vertical piece in the horizontal direction. An upper floor provided at a vehicle interior side of the underframe includes a first heat-insulating material placed at a vehicle interior side surface of the vehicle interior side surface plate, a floor plate provides at an upper surface of the first heat-insulating material using the first curtain rail structure, and a flooring placed at an upper surface of the floor plate. A heat-shielding portion provided at a vehicle exterior side of the underframe includes a second heat-insulating material placed at a vehicle exterior side of the vehicle exterior side surface plate, and a heat-shielding plate provided at a lower surface of the second heat-insulating material using the second curtain rail structure.

According to the disclosure, it is possible to provide a rail vehicle including an underframe that ensures heat-insulating performance and fire-resistant performance while reducing the number of manufacturing steps, and a method for manufacturing a rail vehicle.

Problems, configurations and effects other than those described above will be clarified based on the description of the following embodiments.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a side view of a railway vehicle.

FIG. 2 is a cross-sectional view (a cross-sectional view taken along a line A-A in FIG. 1) intersecting a longitudinal direction of an underframe forming a floor surface of the railway vehicle.

FIG. 3 is a cross-sectional view (an enlarged view of a portion B in FIG. 2) of an underframe having heat-insulating performance and fire-resistant performance and an upper floor provided at an upper surface of the underframe on a vehicle interior side.

FIG. 4 is a flowchart showing a process of constructing a fire-resistant and heat-insulating floor structure at the underframe.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Rail vehicles are a generic term for vehicles operated along a laid track, and mean railway vehicles, road trains, new transportation system vehicles, monorail vehicles, or the like. Hereinafter, an embodiment of the disclosure will be described by exemplifying a railway vehicle, which is a representative example of a rail vehicle, with reference to the drawings.

Hereinafter, an embodiment of the disclosure will be described with reference to the drawings. First, directions will be defined. A longitudinal direction of a railway

vehicle along a track (rail) is defined as an X direction, a width direction of the railway vehicle along a tie (a direction intersecting the track on a horizontal plane) is defined as a Y direction, and a height direction of the railway vehicle intersecting the X direction and the Y direction is defined as a Z direction. Hereinafter, the directions may be simply referred to as an X direction, a Y direction, and a Z direction.

FIG. 1 is a side view of a railway vehicle. The railway vehicle 1 includes a pair of bogies 5 that move along a track 7, and a vehicle structural body 3 supported by the bogies 5. The vehicle structural body 3 is a hexahedron that includes an underframe 10 forming a floor surface, a pair of side structural bodies 20 erected along the X direction at both end portions of the underframe 10 in the Y direction, a pair of end structural bodies (not illustrated) erected along the Y direction at both end portions of the underframe 10 in the X direction, and a roof structural body 40 placed at upper end portions of the side structural bodies 20 and the end structural bodies.

The side structural body 20 includes a side sliding door 24 for a passenger or the like to get on and off, a window 22, and the like. An air conditioner 6 that adjusts a temperature and a humidity in a room is mounted at an upper surface of the roof structural body 40. The air

conditioner 6 may be mounted under a floor of the railway vehicle 1, but is often fixed to the upper surface of the roof structural body 40.

FIG. 2 is a cross-sectional view (a cross-sectional view taken along a line A-A in FIG. 1) intersecting a longitudinal direction of the underframe forming the floor surface of the railway vehicle. The underframe 10 includes a vehicle interior side surface plate 11, a vehicle exterior side surface plate 12, and a plurality of connecting ribs (connecting members) 13 that connect the vehicle interior side surface plate 11 and the vehicle exterior side surface plate 12. In general, the underframe 10 is formed of a hollow extruded shape member in which the surface plate 11, the surface plate 12, and the connecting ribs 13 are integrally extruded and molded in the X direction.

A plurality of curtain rail structures 14 (also referred to as first curtain rail structures), to which a floor plate 52 forming the upper floor 50 and a seat leg 70 are fixed, are integrally formed at the vehicle interior side surface plate 11 by extrusion molding. Similarly, a plurality of curtain rail structures 15 (also referred to as second curtain rail structures) that fix an underfloor device (not illustrated) or a heat-shielding plate 62 forming a heat-shielding portion 60 to be described later are integrally formed at the vehicle exterior side surface

plate 12 by extrusion molding. The curtain rail structure refers to a structure including a channel having a C-shaped cross section.

A heat-insulating material (also referred to as a first heat-insulating material) 53 (including a rubber material 55), a floor plate 52 that restrains the heat-insulating material, and a flooring 51 provided at an upper surface of the floor plate 52 are provided at an upper surface of the vehicle interior side surface plate 11 forming the underframe 10 in order from a vehicle interior side surface plate 11 side. A heat-insulating material (also referred to as a second heat-insulating material) 61 and the heat-shielding plate 62 that restrains the heat-insulating material 61 are provided at the lower surface of the vehicle exterior side surface plate 12 forming the underframe 10 in order from a vehicle exterior side surface plate 12 side.

FIG. 3 is a cross-sectional view (an enlarged view of a portion B in FIG. 2) of the underframe having heat-insulating performance and fire-resistant performance and the upper floor provided at the upper surface of the underframe on the vehicle interior side.

On the track 7 on which the railway vehicle 1 travels, a railroad crossing or the like, in which a road vehicle or the like crosses the track 7 in a plane, is provided. Thus,

assuming that the railway vehicle 1 collides with a road vehicle or the like at the railroad crossing, in case the road vehicle that collides at the railroad crossing and that is caught below the underframe 10 is blasted, the underframe 10 of the railway vehicle 1 is required to have fire-resistant performance.

Further, heat-insulating performance of preventing exhaust heat of electric components, which are provided under the floor of the railway vehicle 1, from entering an inside of the railway vehicle 1 via the underframe 10 is also required.

The fire-resistant performance is a performance of preventing spread of flame to the underframe 10 against a fire that starts below the underframe 10. On the other hand, the heat-insulating performance is a performance of preventing heat of high-temperature outside in summer or exhaust heat of electric components, which are provided under the floor of the railway vehicle 1, from entering the inside of the railway vehicle 1. Hereinafter, the fire-resistant performance and the heat-insulating performance may be referred to as fire-resistant and heat-insulating performance.

The fire-resistant and heat-insulating performance of the underframe 10 forming the floor surface of the railway vehicle 1 is provided by a fire-resistant and heat-

insulating floor structure 18 including the underframe 10, the upper floor 50 laid at the upper surface of the underframe 10, and the heat-shielding portion 60 laid at the lower surface of the underframe 10.

As described above, the underframe 10 is formed by the extruded shape member including the vehicle interior side surface plate 11, the vehicle exterior side surface plate 12 spaced apart from the vehicle interior side surface plate 11 substantially in parallel, and the connecting ribs 13 that connect the vehicle interior side surface plate 11 and the vehicle exterior side surface plate 12. The curtain rail structure 14, to which the seat leg 70 and the floor plate 52 are fixed, is integrally extruded and molded at the vehicle interior side surface plate 11. Similarly, the curtain rail structure 15, to which the heat-shielding plate 62 is fixed, is integrally extruded and molded at the vehicle exterior side surface plate 12.

The curtain rail structure 14 includes a pair of vertical pieces 14b that include lower end portions connected to the vehicle interior side surface plate 11 and that extend in the X direction, a horizontal piece 14a that extends in the horizontal direction in a manner of facing end portions of the vertical pieces 14b in the Z direction, and a section 14c that extends substantially horizontally from a central portion of the vertical pieces 14b in the Z

direction in an opposite direction from an extending direction of the horizontal piece 14a. The vehicle interior side surface plate 11, the vertical pieces 14b, and the horizontal piece 14a form a channel structure having a C-shaped cross section.

The curtain rail structure 15 includes a pair of vertical pieces 15b that include upper end portions connected to the vehicle exterior side surface plate 12 and that extend in the X direction, and a horizontal piece 15a that extends in the horizontal direction in a manner of facing lower end portions of the vertical pieces 15b in the Z direction. The vehicle exterior side surface plate 12, the vertical pieces 15b, and the horizontal piece 15a form a channel structure having a C-shaped cross section.

The upper floor 50 includes the heat-insulating material 53 placed at the upper surface of the vehicle interior side surface plate 11, the floor plate 52 placed at an upper surface of the heat-insulating material 53, and the flooring 51 placed at the upper surface of the floor plate 52. The heat-insulating material 53 is made of a foamed material of a synthetic resin having flame retardancy and heat-insulating properties. The floor plate 52 itself is made of wood plywood having fire-resistant and heat-insulating performance.

The heat-insulating material 53 and a rubber material

55 that supports the floor plate 52 are disposed in a region (between adjacent curtain rail structures 14) defined by the curtain rail structure 14 of the vehicle interior side surface plate 11. The rubber material 55 is discretely disposed on the vehicle interior side surface of the vehicle interior side surface plate 11 along the X direction and the Y direction.

The floor plate 52 is a floating floor structure in which both end portions of the floor plate 52 in the Y direction are supported by the section 14c of the curtain rail structure 14, and a central portion of the floor plate 52 in the Y direction is elastically supported by the rubber material 55.

A restraining plate 54 straddles the end portion of the floor plate 52 in the Y direction placed at the section 14c and the horizontal piece 14a of the curtain rail structure 14. Both end portions of the floor plate 52 in the Y direction, the restraining plate 54, and the section 14c of the curtain rail structure 14 are integrally and mechanically fixed by a mechanical fastening portion 82.

The restraining plate 54 is discretely provided at a position along the X direction and corresponding to the seat leg 70. The restraining plate 54 has a hole through which the mechanical fastening portion 82 (for example, a bolt) passes to hold a head portion of the mechanical fastening

portion 82, and a hole through which a mechanical fastening portion 80 (for example, a bolt) passes. The mechanical fastening portion 82 fastens the floor plate 52 to the section 14c of the curtain rail structure 14. The mechanical fastening portion 80 fastens the seat leg 70 to the horizontal piece 14a of the curtain rail structure 14.

Interior side surfaces of the floor plate 52 and the restraining plate 54 are covered (laid) by the flooring 51. A region in which the seat leg 70 of seats of the flooring 51 is fastened is notched, and the seat leg 70 directly abuts against the restraining plate 54.

According to this configuration, since it is not necessary to divide the flooring 51 in the Y direction for fastening the seat leg 70, it is possible to reduce the number of manufacturing steps of constructing the flooring 51. The seat leg 70, which is attached to the upper surface of the restraining plate 54 placed at the upper surface of the horizontal piece 14a of the curtain rail structure 14, is fastened to the curtain rail structure 14 (the horizontal piece 14a) by the mechanical fastening portion 80 in a mode of fastening the restraining plate 54 together. Here, fastening can be performed by screwing, through a gap of facing edges of the horizontal piece 14a, a screw portion of a bolt into a nut inserted into the channel structure having the C-shaped cross section. The bolt penetrates the

support plate of the seat leg 70 and the hole of the restraining plate 54.

Since a structure of the upper floor 50 using the curtain rail structure 14 can reduce a thickness dimension of the upper floor 50 in the Z direction, a wide vehicle interior space in the Z direction can be formed.

The heat-shielding portion 60 includes a heat-insulating material 61 disposed at the lower surface of the vehicle exterior side surface plate 12, and a heat-shielding plate 62 that holds the heat-insulating material 61. The heat-insulating material 53 is made of a foamed material of a synthetic resin having flame retardancy and heat-insulating properties. The heat-shielding plate 62 is a stainless steel plate that is incombustible and has high strength so as to withstand a collision of a ballast laid on the track, and has a hole through which a screw portion of the mechanical fastening portion 84 passes. The head portion of the screw portion of the mechanical fastening portion 84 is inserted into the curtain rail structure 15 integrally molded with the underframe 10. After the mechanical fastening portion 84 is inserted into the hole of the heat-shielding plate 62, the heat-shielding plate 62 is fastened to the horizontal piece 15a of the curtain rail structure 15. Here, in the bolt whose head portion is held in the channel structure having the C-shaped cross section,

the screw portion protruding downward through a gap between the facing edges of the horizontal piece 15a is passed through the hole of the heat-shielding plate 62 and then is screwed into a nut, so that the heat-shielding plate 62 can be fastened. In the channel structure having the C-shaped cross section, when the polygonal head portion or the nut of the bolt comes into contact with an inner wall and is rotatably fixed, the fastening can be performed only by performing fastening on one side. Therefore, the workability is high.

FIG. 4 is a flowchart showing a process of constructing the fire-resistant and heat-insulating floor structure at the underframe. S in S10 to S120 shown in the flowchart means a step. A method for manufacturing a railway vehicle will be described with reference to the flowchart in FIG. 4.

In S10, work of constructing the fire-resistant and heat-insulating floor structure at the underframe is started.

In S20, the underframe 10 (a railway vehicle structural body) is prepared. Basically, the fire-resistant and heat-insulating floor structure is constructed at the underframe 10 of the railway vehicle structural body assembled into a hexahedron by the underframe 10, the side structural body 20, the end structural body, and the roof structural body 40.

Assembly of Upper Floor 50

In S30, the heat-insulating material 53 and the rubber material 55 are provided in a region (the vehicle interior side surface of the vehicle interior side surface plate), defined by the curtain rail structure 14 at the upper surface (the vehicle interior side surface) of the vehicle interior side surface plate 11 of the underframe 10.

In S40, the floor plate 52 is prepared. In a manner of covering the heat-insulating material 53 and the rubber material 55 that are placed in S30, one end portion of the floor plate 52 in the width direction is placed at the section 14c that faces the floor plate 52, and the other end portion of the floor plate 52 in the width direction is placed at the section 14c that faces the floor plate 52.

In S50, the restraining plate 54 is provided at the end portion of the floor plate 52 in the width direction and the upper surface of the horizontal piece 14a of the curtain rail structure 14.

In S60, the end portions of the restraining plate 54 and the floor plate 52 in the width direction are fastened to the section 14c of the curtain rail structure 14 using the mechanical fastening portion 82. Here, since the bolt whose head portion is held by the restraining plate 54 is inserted into the hole of the floor plate 52 and then screwed

into a screw hole of the section 14c, it is not necessary to use a nut.

In S70, the upper surface (the vehicle interior side surface) of the floor plate 52 is covered with the flooring 51, and the seat leg 70 is disposed at the upper surface of the restraining plate 54.

In S80, the seat leg 70 and the restraining plate 54 are fastened to the horizontal piece 14a of the curtain rail structure 14 using the mechanical fastening portion 80.

Through the above steps, the upper floor 50, which includes the heat-insulating material 53, the floor plate 52, the flooring 51, and the restraining plate 54 that fixes the heat insulating material 53, the floor plate 52, and the flooring 51 to the underframe 10 and which has the heat-insulating performance, can be formed using the curtain rail structure 14 that is integrally extruded and molded with the vehicle interior side surface plate 11 forming the underframe 10. According to this configuration, it is not necessary to prepare the curtain rail structure 14 separately from the underframe 10, so that it is possible to form the upper floor 50 while reducing the number of manufacturing steps.

Assembly of Heat-shielding Portion 60

In S90, the heat-insulating material 61 is provided

in a region (the vehicle exterior side surface of the vehicle exterior side surface plate) defined by the curtain rail structure 15 at the lower surface of the vehicle exterior side surface plate 12 of the underframe 10.

In S100, a head portion of the mechanical fastening portion 84 is inserted into the curtain rail structure 15.

In S110, since the screw portion of the mechanical fastening portion 84 protrudes downward due to gravity, the screw portion is passed through the hole of the heat-shielding plate 62, and the heat-shielding plate 62 is fastened to the horizontal piece 15a and provided at the lower surface of the underframe 10 in a manner of covering the heat-insulating material 61.

In S120, the process of constructing the fire-resistant and heat-insulating floor structure at the underframe is completed.

According to the railway vehicle having the above-described configuration, since it is not necessary to separately prepare fixtures that fix the floor plate 52 to the underframe 10, component costs can be reduced. When the fixtures are used separately, it is necessary to position the fixtures at the upper surface of the vehicle interior side surface plate 11 and then fix the fixtures. However, according to the present embodiment, steps for positioning and fixing the fixtures can be omitted.

Further, it is possible to mechanically fix only both end portions of the floor plate 52 in the Y direction to the section 14c of the curtain rail structure 14, and to discretely and elastically support the central portion of the floor plate 52 in the Y direction by the rubber material 55. Accordingly, even when the underframe 10 is vibrated due to vibration of the underfloor device (including electrical components) provided under the floor of the underframe 10, since the vibration of the underframe 10 is less likely to be transmitted to the upper floor, an increase in vehicle interior noise caused by the mechanical vibration of the underfloor device can be prevented.

Further, since it is not necessary to separately prepare fixtures that fix the heat-shielding plate 62 to the underframe 10, the component costs can be reduced. When the fixtures are used separately, it is necessary to position the fixtures at the upper surface of the vehicle interior side surface plate 12 and then fix the fixtures. However, according to the present embodiment, steps for positioning and fixing the fixtures can be omitted.

Further, according to the present embodiment, the upper floor 50 having increased heat-insulating performance is provided at the vehicle interior side of the underframe 10, and the heat-shielding portion 60 having increased fire-resistant performance is provided at the vehicle exterior

side of the underframe 10. Therefore, since the underframe 10 has a high heat-insulating performance against the exhaust heat of the underfloor device in summer when a vehicle exterior temperature is high, the heat transferred via the underframe 10 is prevented from entering the vehicle interior. Accordingly, since a rise in vehicle interior temperature is controlled and an operating rate of the air conditioner 6 is reduced, energy saving can be promoted.

According to the present embodiment having the above configuration, the railway vehicle including the underframe having enhanced heat-insulating and fire-resistant performance while reducing the number of manufacturing steps can be provided.

What is claimed is:

1. A rail vehicle including an underframe, wherein the underframe includes a vehicle interior side surface plate, a vehicle exterior side surface plate, and a connecting member that connects the vehicle interior side surface plate and the vehicle exterior side surface plate, and the underframe is formed of a hollow extruded shape member that is extruded and molded along a longitudinal direction of the rail vehicle,

the vehicle interior side surface plate includes a plurality of first curtain rail structures including a vertical piece whose lower end portion is connected to the vehicle interior side surface plate, a horizontal piece that extends from an upper end portion of the vertical piece to one side in a horizontal direction, and a section that extends from the vertical piece to the other side in the horizontal direction,

the vehicle exterior side surface plate includes a plurality of second curtain rail structures including a vertical piece whose lower end portion is connected to the vehicle exterior side surface plate and a horizontal piece that extends from an upper end portion of the vertical piece in the horizontal direction,

an upper floor provided at a vehicle interior side of

the underframe includes a first heat-insulating material placed at a vehicle interior side surface of the vehicle interior side surface plate, a floor plate provided at an upper surface of the first heat-insulating material using the first curtain rail structure, and a flooring placed at an upper surface of the floor plate, and

a heat-shielding portion provided at the vehicle exterior side of the underframe includes a second heat-insulating material placed at a vehicle exterior side of the vehicle exterior side surface plate, and a heat-shielding plate provided at a lower surface of the second heat-insulating material using the second curtain rail structure.

2. The rail vehicle according to claim 1, wherein

the floor plate is supported by a rubber material discretely provided at the vehicle interior side of the vehicle interior side surface plate, and

an end portion of the floor plate of the rail vehicle in a width direction is placed at the section.

3. The rail vehicle according to claim 2, wherein

the upper floor includes a restraining plate placed at an upper surface of the end portion of the floor plate in the width direction, and

the restraining plate, the end portion of the floor plate in the width direction, and the section are fixed by a mechanical fastening portion.

4. A method for manufacturing a rail vehicle according to claim 3, the method comprising:

disposing the first heat-insulating material and the rubber material at the vehicle interior side surface plate defined by the first curtain rail structure,

placing the floor plate above the first heat-insulating material and the rubber material,

disposing the restraining plate above the horizontal piece of the first curtain rail structure and the end portion of the floor plate in the width direction, and

fastening the restraining plate and the floor plate to the section using the mechanical fastening portion.

5. The method for manufacturing a rail vehicle according to claim 4, the method further comprising:

disposing the second heat-insulating material at the vehicle exterior side surface plate defined by the second curtain rail structure,

disposing the heat-shielding plate below the second heat-insulating material and the horizontal piece of the second curtain rail structure, and

fastening the heat-shielding plate to the horizontal piece of the second curtain rail structure using the mechanical fastening portion.