

TITLE OF THE INVENTION

RAIL VEHICLE AND METHOD FOR MANUFACTURING RAIL VEHICLE

BACKGROUND OF THE INVENTION

1. Field of the Invention

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

2. Description of the Related Art

In general, a railway vehicle operated along a laid track is required to have heat insulating performance to suppress intrusion of heat in the atmosphere in summer, in which an outside air temperature is higher than a stage frame constituting a floor surface and heat generated by devices placed under the floor, into the vehicle via the stage frame.

JP 2009-196531 A proposes a floor structure of a magnetic levitation vehicle that has a small space under the floor and can have a fire resistance function similar to the conventional fire resistance function without reducing an arrangement space for cables, pipes, devices, and the like disposed under the floor. JP 2009-196531 A discloses a technique in which, in a floor structure of a magnetic levitation vehicle in which a lower surface of a floor panel is supported by a beam structure in which a

plurality of beam members extending in the front-back direction of the vehicle and a plurality of beam members extending in the vehicle width direction are combined with each other, a plate-shaped expansion-type heat insulating material is disposed below the floor panel.

SUMMARY OF THE INVENTION

In general, regarding a railway vehicle having heat resistance on a surface on the vehicle outer side of a lower surface of a stage frame forming a floor portion of the railway vehicle, a heat insulating material that suppresses transfer of heat between the inside and outside of the vehicle, a construction work is performed with respect to a protective plate that restrains the heat insulating material and protects the heat insulating material from a flying object (ballast or the like laid on a track), and the like; and therefore, the manufacturing man-hour of the railway vehicle tends to increase.

The present invention has been made in view of problems of the prior art, and an object of the present invention is to provide a rail vehicle having a stage frame with enhanced heat insulation while reducing manufacturing man-hour, and to provide a method for manufacturing the rail vehicle.

To solve the above problems, one of typical rail

vehicles of the present invention is a rail vehicle includes:

a stage frame constituted by a hollow extruded material that is extrusion molded along a longitudinal direction of the rail vehicle, the stage frame constituting a floor surface and including: a vehicle inner side surface panel; a vehicle outer side surface panel, and a connecting member connecting the vehicle inner side surface panel and the vehicle outer side surface panel,

wherein the vehicle outer side surface panel has a plurality of curtain rail structures each including: vertical pieces whose first ends in a height direction are each connected to the vehicle outer side surface panel; and horizontal pieces each extending horizontally in one direction from a second end of one of the vertical pieces; and

a heat insulating unit configured on a vehicle outer side of the stage frame, the heat insulating unit including: a heat insulating material provided, between the curtain rail structures, on a vehicle outer side surface of the vehicle outer side surface panel; a heat insulating panel that holds the heat insulating material between the heat insulating panel and the vehicle outer side surface panel; an insulator provided between the horizontal pieces of each of the curtain rail structures and the heat

insulating panel; and a mechanical fastening portion that fixes the heat insulating panel to the curtain rail structures.

The present invention makes it possible to provide a rail vehicle having a stage frame with enhanced heat insulation while reducing manufacturing man-hour, and to provide a method for manufacturing the rail vehicle.

Problems, configurations, and advantageous effects other than the above will be clarified by the following description of the embodiment.

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 line A-A in Fig. 1) intersecting a longitudinal direction of the railway vehicle;

Fig. 3 is a cross-sectional view (an enlarged part of part B in Fig. 2) of a stage frame constituting a floor of the railway vehicle and having high heat insulation;

Fig. 4 is an exploded view illustrating elements constituting the stage frame with enhanced heat insulation;

Fig. 5 is a flowchart illustrating a process of assembling a heat insulating unit and attaching the heat insulating unit to a lower surface of the stage frame of the railway vehicle;

Fig. 6 is a cross-sectional view (a cross-sectional view taken along line C-C in Fig. 7) of the heat insulating unit before being attached to the stage frame of the railway vehicle; and

Fig. 7 is a plan view of the heat insulating unit before being attached to the stage frame of the railway vehicle.

DESCRIPTION OF THE PREFERRED EMBODIMENT

The rail vehicle is a collective term for vehicles operated along a laid track, and means a railway vehicle, a streetcar, a new transportation system vehicle, a monorail vehicle, and the like. Hereinafter, with reference to the drawings, an embodiment of the present invention will be described by exemplifying a railway vehicle as a typical example of the rail vehicle.

Hereinafter, an embodiment according to the present invention will be described with reference to the drawings. First, directions are defined. A longitudinal direction (or rail direction) of the railway vehicle is defined as an x direction, a width direction (or railroad tie direction) of the railway vehicle is defined as a y direction, and a height direction of the railway vehicle is defined as a z direction. Hereinafter, the directions may be simply referred to as x direction, y direction, and z direction.

Fig. 1 is a side view of a railway vehicle, and Fig. 2 is a cross-sectional view intersecting a longitudinal direction of the railway vehicle. The railway vehicle 1 includes a pair of carriages 7 moving along a track 9 and a vehicle structure 3 supported by the carriages 7. The vehicle structure 3 is a hexahedron including: a stage frame 10 constituting a floor surface; a pair of side structures 20 vertically disposed, along the x direction, at both ends of the stage frame 10 in the y direction; a pair of gable structures vertically disposed along the y direction at both ends, of the stage frame 10, in the x direction; and a roof structure 40 placed on upper ends of the side structures 20 and the gable structures.

The side structures 20 include a side sliding door 24 used for getting on and off of passengers and the like, a window 22, and the like. On an upper surface of the roof structure 40, there is mounted an air conditioner 42 that adjusts temperature and humidity in a cabin. Inside the railway vehicle 1 (on an upper surface of a floor portion of the stage frame 10), there is provided seats 18 and the like.

Fig. 3 is a cross-sectional view (an enlarged part of part B in Fig. 2) of the stage frame constituting the floor of the railway vehicle and having high heat insulation, and Fig. 4 is an exploded view illustrating

elements constituting the stage frame with enhanced heat insulation. The stage frame 10 is constituted by a hollow extruded material in which there are extrusion molded, in the x direction, a vehicle inner side surface panel 11, a vehicle outer side surface panel 12, and connecting ribs (connecting members) 13 connecting both panels.

On vehicle outer side surface panel 12, there are curtain rail structures 15 integrally molded to be arranged in the y direction at an equal interval (pitch) P to hold a heat insulating unit 50 (to be described later) on a lower surface of the stage frame 10. As illustrated in Fig. 4, the curtain rail structures 15 each have a channel structure having a C-shaped cross-section and including horizontal pieces 15H, vertical pieces 15V, and the vehicle outer side surface panel 12.

The heat insulating unit 50 includes: a heat insulating panel 57 having a flat plate shape; protective plates 58 provided along the x direction on the heat insulating panel 57; heat insulating materials 55 provided, at a first interval, in wide regions (sections corresponding to the pitch P) each partitioned by one protective plate 58 and another protective plate 58; and insulators 56 provided, at a second interval narrower than the first interval, in narrow regions each partitioned by one protective plate 58 and another protective plate 58.

Each protective plate 58 includes a horizontal portion 58L and a vertical portion 58V vertically disposed on one end, of the horizontal portion 58L, in the y direction, and the protective plate 58 has an approximately L-shaped cross-sectional shape intersecting the x direction. The pair of protective plates 58 provided at the first interval are disposed such that the horizontal portions 58L are directed toward each other, and the pair of protective plates 58 provided at the second interval are disposed such that the horizontal portions 58L are directed in opposite directions.

The heat insulating unit 50 is fastened to the curtain rail structures 15 of the vehicle outer side surface panel 12 on the lower surface of the stage frame 10 with mechanical fastening portions 90. Here, the heat insulating panel 57 can be fastened in the following manner. Threaded portion of bolts whose heads are held in the channel structures having the C-shaped cross-section protrude through between ends, of the horizontal pieces 15H, facing each other, and the protruding threaded portions are put through holes in the heat insulating panel 57 and are then screwed with nuts.

If the heat insulating panel 57 constituting the heat insulating unit 50 were directly in contact with the curtain rail structures 15, heat would be transferred from

the heat insulating panel 57 to the curtain rail structures 15, and the transferred heat would be transferred, by conduction, from the curtain rail structures 15 through the vehicle outer side surface panel 12 and connecting ribs 13 to the vehicle inner side surface panel 11, and as a result, would enter the inside of the railway vehicle 1. To address this issue, in the present embodiment, the insulators 56 are interposed on contact surfaces between the horizontal pieces 15H of the curtain rail structures 15 and the heat insulating panel 57 to suppress heat transfer from the heat insulating panel 57 to the curtain rail structures 15.

Fig. 5 is a flowchart illustrating a process of assembling the heat insulating unit and then attaching the heat insulating unit to the lower surface of the stage frame of the railway vehicle. Fig. 6 is a cross-sectional view (a cross-sectional view taken along line C-C in Fig. 7) of the heat insulating unit before being attached to the stage frame of the railway vehicle. Fig. 7 is a plan view of the heat insulating unit before being attached to the stage frame of the railway vehicle. A method for manufacturing a railway vehicle will be described with reference to the flowchart of Fig. 5.

Each step of the flowchart of Fig. 5 will be described with reference to Figs. 6 and 7. The letter S in

S10 to S100 written in the flowchart means a step.

In step S10, start a work of assembling the heat insulating unit and attaching the heat insulating unit to the lower surface of the stage frame of the railway vehicle.

In step S20, the heat insulating panel 57 having a flat plate shape is prepared. For the heat insulating panel 57, a stainless-steel flat plate having high strength is used to withstand collision of ballast laid on a track. In the case of a vehicle traveling on a slab track or the like where there is no possibility of ballast being scattered, a stainless-steel flat plate is not necessarily used.

In step S30, a pair of protective plates 58 are disposed on the heat insulating panel 57 having a flat plate shape such that a y-direction dimension between the vertical portions 58V of the pair of protective plates 58 facing each other is M2, and the horizontal portions 58L of the protective plates 58 are fixed. The dimension M2 is set slightly smaller than a y-direction dimension L2 between the vertical pieces 15V of one and the other of the curtain rail structures 15 that are adjacent to each other with the heat insulating materials 55 therebetween. Here, regarding the pair of protective plates 58 that are close to each other with their horizontal portions 58L being

directed in opposite directions, a y-direction dimension between the vertical portions 58V is $M1$, and regarding the pair of protective plates 58 whose horizontal portions 58L are directed toward each other, a y-direction dimension between the vertical portions 58V is $M2$ ($> M1$).

In step S40, the insulators 56 made of a material having a low thermal conductivity are provided between the vertical portions 58V of each pair of protective plates 58 that are close to each other with their horizontal portions 58L being directed in opposite directions.

As shown in Fig. 7, the insulators 56 have a rectangular plate shape having long sides along the x direction, and are disposed on the surface of heat insulating panel 57 on the stage frame 10 side. Specifically, the insulators 56 are discretely disposed in the x direction such that the longitudinal direction of the insulators 56 are oriented along the x direction, avoiding the holes 57a through which the mechanical fastening portions 90 for fixing the insulators 56 to the stage frame 10 pass. In addition, the insulators 56 are discretely disposed in the y direction between the vertical portions 58V of each pair of protective plates 58 that are close to each other with their horizontal portions 58L being directed in opposite directions.

In step S50, the flat heat insulating materials 55

are prepared and are each fixed between the vertical portions 58V of one of the pairs of protective plates 58 which are fixed to the heat insulating panel 57 and whose horizontal portions 58L are directed toward each other. A dimension of the heat insulating materials 55 in the y direction is set to be slightly smaller than the y-direction dimension M2 at which the vertical portions 58V of each pair of protective plates 58 whose horizontal portions 58L are directed toward each other. A thickness dimension t2 of the heat insulating materials 55 in a free state (a state where no external force is applied) is set to be larger than a height dimension t1 of the vertical portions 58V of the protective plates 58. The heat insulating materials 55 are fixed to the surface of the heat insulating panel 57 on the stage frame 10 side.

In step S60, the heads of the mechanical fastening portions (bolts) 90 are set (provided) in the curtain rail structures 15 that are integrally extrusion molded on the vehicle outer side surface panel 12 of the stage frame 10. The head portions of the mechanical fastening portions 90 are held in the curtain rail structures 15, and the threaded portions protrude by gravity through between the edges, of the horizontal pieces 15H, facing each other. Note that when a polygonal head portion of each bolt comes in contact with inner walls in the channel structure having

the C-shaped cross-section and is thus rotationally fixed, fastening can be performed only by fastening from one side, and thus workability is excellent.

In step S70, the threaded portions of the mechanical fastening portions 90 are passed through the holes 57a of the heat insulating panel 57 to position the heat insulating panel 57 on the lower surface of the stage frame 10.

In step S80, the nuts are screwed with the threaded portions of the mechanical fastening portions 90 and are then fastened. In the process of fastening the mechanical fastening portions 90, the vertical portions 58V of the protective plates 58 are guided by the vertical pieces 15V of the curtain rail structures 15, thereby suppressing inclination of the heat insulating panel 57. A height dimension t_1 of the vertical portions 58V of the protective plates 58 is set slightly smaller than a height dimension t_3 of the curtain rail structures 15 integrally molded with the vehicle outer side surface panel 12 of the stage frame 10.

At the same time, the heat insulating materials 55 are compressed in the z direction to increase its density (the void rate is reduced). In general, because a heat insulating material having a high density is excellent in heat insulation as compared with a heat insulating material

having a low density, the compressed heat insulating unit 50 has higher thermal resistance and thus higher heat insulating performance.

When the heat insulating material 55 are compressed in the z direction, both ends in the y direction protrude, but since both ends are restrained by the vertical portions 58V of the protective plate 58, the protrusion to each curtain rail structure 15 side is suppressed. Therefore, when the mechanical fastening portions 90 are fastened up, the heat insulating materials 55 are restrained from being sandwiched between the surfaces, of the horizontal pieces 15H of the curtain rail structures 15, on the heat insulating unit 50 side and the heat insulating panel 57; and therefore an appropriate axial force can be secured for the mechanical fastening portions 90 over a long period of time.

In step S90, the mechanical fastening portions 90 are fastened with an appropriate fastening torque to fix the heat insulating panel 57 to the lower surface of the stage frame 10. At this time, because the front end of the vertical portion 58V of each protective plate 58 comes into contact with the vehicle outer side surface panel 12, the heat insulating panel 57 is prevented from further getting closer to the vehicle outer side surface panel 12, so that excessive compression of the heat insulating materials 55

can be suppressed. Note that because an area of a contact surface between each vertical portion 58V and the vehicle outer side surface panel 12 is relatively small, an amount of heat passing through the contact surface is small.

In step S100, the work of fixing the heat insulating unit 50 to the stage frame 10 is completed.

With the railway vehicle having the above configuration, since the heat insulating unit 50 including the heat insulating materials is disposed on the lower surface of the stage frame 10, it is possible to restrain exhaust heat of underfloor devices and the like provided below the stage frame 10 and exhaust heat of a main motor that drives the carriages 7 from being transmitted through the stage frame 10 and entering the inside of the railway vehicle 1.

Further, when heat insulating unit 50 is attached to the lower surface of the stage frame 10, the heat insulating materials 55 constituting the heat insulating unit 50 are sandwiched and compressed between the vehicle outer side surface panel 12 of the stage frame 10 and the heat insulating panel 57, so that a heat insulating material having a larger thickness (having higher heat insulating performance) can be used without previously compressing the heat insulating materials 55 by outwork.

Further, since the structure is configured such that

the vertical portions 58V of the protective plates 58 fixed to the heat insulating panel 57 are guided by the vertical pieces 15V of the curtain rail structures 15, the heat insulating materials 55 protruding in the y direction in the process of compressing the heat insulating materials 55 in the z direction can be restrained from being sandwiched between the insulators 56 provided on the protective plates 58 and the horizontal pieces 15H of the curtain rail structures 15 of the stage frame 10. Therefore, it is possible to suppress a decrease, in the axial forces of the fastened mechanical fastening portions 90, due to aging deterioration of the heat insulating materials 55 sandwiched when the heat insulating unit 50 is attached to the lower surface of the stage frame 10, so that reliability can be enhanced.

In addition, according to an underfloor structure of the railway vehicle according to the present invention, a fiber-based heat insulating material is attached in a compressed manner, so that heat insulation can be enhanced due to reduction in the void rate of the fiber-based heat insulating material, so that it is possible to effectively suppress a temperature rise in the stage frame.

Further, because the heat insulating unit 50 manufactured by outwork can be fixed below the stage frame 10, it is possible to prepare the heat insulating unit 50

in a process different from the process of manufacturing the railway vehicle 1, so that the overall manufacturing man-hour of the railway vehicle 1 can be reduced.

What is claimed is:

1. A rail vehicle comprising:

a stage frame constituted by a hollow extruded material that is extrusion molded along a longitudinal direction of the rail vehicle, the stage frame constituting a floor surface and including:

a vehicle inner side surface panel;

a vehicle outer side surface panel, and

a connecting member connecting the vehicle inner side surface panel and the vehicle outer side surface panel, wherein the vehicle outer side surface panel has a plurality of curtain rail structures each including:

vertical pieces whose first ends in a height direction are each connected to the vehicle outer side surface panel; and

horizontal pieces each extending horizontally in one direction from a second end of one of the vertical pieces; and

a heat insulating unit configured on a vehicle outer side of the stage frame, the heat insulating unit including:

a heat insulating material provided, between the curtain rail structures, on a vehicle outer side surface of the vehicle outer side surface panel;

a heat insulating panel that holds the heat insulating material between the heat insulating panel and the vehicle outer side surface panel;

an insulator provided between an entire length of the horizontal pieces of each of the curtain rail structures and the heat insulating panel; and

a mechanical fastening portion that fixes the heat insulating panel to the curtain rail structures.

2. The rail vehicle according to claim 1, wherein the heat insulating material in a free state has a thickness dimension larger than a dimension from a first end to a second end of the vertical pieces in a height direction, and

the heat insulating material is compressed by fastening of the mechanical fastening portion that fixes the heat insulating panel to the curtain rail structures in a height direction.

3. The rail vehicle according to claim 2, wherein the heat insulating panel includes:

a plurality of protective plates each having an approximately L-shaped cross-section intersecting the longitudinal direction, each of the protective plates including:

a horizontal portion; and

a vertical portion vertically provided at an end, of

the horizontal portion, in a width direction of the horizontal portion,

an interval between the vertical portions of a pair of the protective plates whose horizontal portions are directed toward each other is set larger than an interval between the vertical portion of a pair of the protective plates whose horizontal portions are directed in opposite directions, and

the curtain rail structures are disposed between the vertical portions of respective ones of the pairs of the protective plates whose horizontal portions are directed in opposite directions.

4. The rail vehicle according to claim 3, wherein front edges of the vertical portions of the protective plates are in contact with the vehicle outer side surface panel.

5. A method for manufacturing the rail vehicle according to claim 1, comprising:

disposing, between the curtain rail structures, the heat insulating material on the vehicle outer side surface panel;

disposing the insulators across an entire length of the horizontal pieces of respective ones of the curtain rail structures; and

fixing the heat insulating panel to the curtain rail

structures while compressing the heat insulating material by using the mechanical fastening portion.

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

fixing protective plates to the heat insulating panel, each of the protective plates having an approximately L-shaped cross-section intersecting the longitudinal direction and including:

a horizontal portion; and

a vertical portion vertically provided at an end, of the horizontal portion, in a width direction of the horizontal portion;

disposing the heat insulating material between the vertical portions of the protective plates whose horizontal portions are directed toward each other;

disposing the insulator between the vertical portions of the protective plates whose horizontal portions are directed in opposite directions; and

fixing the heat insulating panel to the curtain rail structures while causing the vertical portions of the protective plates whose horizontal portions are directed in opposite directions to be guided to the curtain rail structures and compressing the heat insulating material by using the mechanical fastening portion.