

New Automated Guideway Transit System Yurikamome 7300 Series Carriages



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Mitsubishi Heavy Industries, Ltd. (MHI) developed the “Yurikamome 7300 Series” carriage for the new Automated Guideway Transit (AGT) system which offers an increased transportation volume of more than 10% compared with existing carriages. The new AGT system is an urban transportation system using rubber tires, which reduces noise and vibrations. To increase the riding capacity, it is necessary to reduce the weight of the carriage. The “Yurikamome 7300 Series” carriage has a weight that is 10% lower compared with existing carriages. This reduction in weight has led to not only the increase of the carrying capacity, but also to the reduction of the life cycle cost of the whole system through energy saving and the extension of the life of the parts. These efforts have been well received by the new AGT system operator. In this article, the “Yurikamome 7300 Series” carriage is described.

1. Introduction

The new AGT system that runs on rubber tires features a high degree of freedom in route planning, low construction cost, a short construction period, low operation cost and low vibration and noise, and it has been introduced as an urban transportation system with a medium transport capacity in various countries around the world. For the Yurikamome line which opened in 1995, the increase of the transportation volume was a challenge in view of events held at facilities located along the line such as Tokyo Big Sight. The “Yurikamome 7300 Series” carriage was developed addressing the challenge head-on.

2. Development and background

To increase the carrying capacity of carriages, it is effective that 1) the passenger standing area is increased, and 2) passengers standing near the doors can smoothly board the carriage. In existing carriages, the arrangement of box-type seats was adopted and the width of the aisles was only 600 mm. As such, it was difficult for passengers who boarded the carriage to move from the vicinity of the doors toward the center or ends of the carriage, and as a result, some passengers couldn't board the train. It also took time for passengers sitting on the window side of the box-type seat to disembark trains, which lengthened the time required for passenger boarding and disembarking, resulting in the reduction of the transportation volume. In the arrangement of box-type seats, the total area that seats occupy in a carriage is large and the area for standing passengers is small. Therefore, the number of passengers in an entire carriage is smaller than that in the longitudinal seat type arrangement.

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For the “Yurikamome 7300 Series” carriages, the structure of the bogies was changed from the conventional steering type to the 4-guide wheel type (**Figure 1**), which achieved the reduction of the lateral movement of the vehicle body from the conventional 95 mm to 20 mm. In addition, the outfitting structure was improved and the interior space was increased by 138 mm compared with the existing space, thereby increasing the floor area of the carriage.

Furthermore, through the adoption of the longitudinal seat type arrangement (**Figure 2**), the standing floor area was increased and the aisle width of 1 100 mm was secured. As a result, the number of passengers in the standing area was increased and passengers can now smoothly move to the centers or ends of the carriages without staying near the doors (**Figure 3**). The time required for passengers on seats to disembark was also substantially shortened. In addition to the change of the seating arrangement, the change of the doors from the single-side opening type to the both-side opening type also contributed to the shortening of the time required for the full opening of the doors, resulting in the reduction of passenger boarding and disembarking time. Existing vehicle air conditioning produced imbalances in temperatures in the carriage, the central area being too cool and the ends being too hot, causing a slowdown in the movement of the passengers in the carriage. The new AGT carriage is provided with air conditioning ducts (**Figure 4**) for the first time, to make the temperature in the carriage uniform and provide a comfortable environment for passengers. For the front part of the carriage where sightseeing passengers gather, a wide front face expanding the view from floor to ceiling and an interior design featuring round curves without sharp corners for the improvement of safety were adopted, allowing more people including children and the elderly to enjoy themselves with ease in that space (**Figure 5**).



Figure 1 Four-guide-wheel-type bogie



Figure 2 Arrangement of longitudinal seats

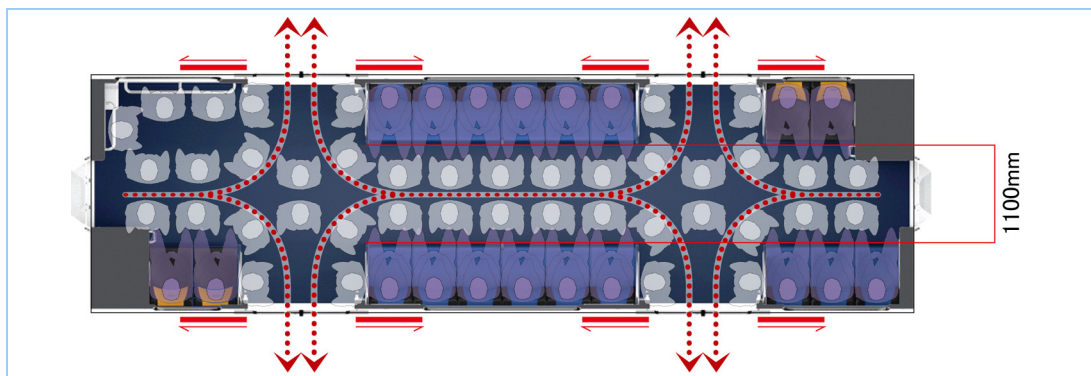


Figure 3 Passenger flow lines secured by the expansion of the aisle width



Figure 4 Air conditioning duct



Figure 5 Front part providing a superior view

3. Specifications and characteristics of Yurikamome 7300 Series carriages

The improvement of the carriage interior design resulted in an increase in passenger capacity of more than 10% compared with existing carriages. To reduce the weight of the carriage resulting from the weight of the increase number of passengers, the following measures were taken:

- (1) Stainless steel is normally used for the body material of the carriage. For the new carriage, all double skin aluminum material was adopted, achieving both a reduction of weight and the securing of rigidity. In addition, making use of the material shape, the installation method of outfitting was simplified and the number of parts was reduced.
- (2) The Friction Stir Welding (FSW) jointing method, which does not create distortion, was adopted to weld the aluminum panels of the side walls, and hairline finishing was applied to make a beautiful glossy body without coating to reduce the weight of coating and putty (**Figure 6**).



Figure 6 Uncoated aluminum body formed with FSW

- (3) Thorough analyses and verification tests for vehicle structural members such as the bogie frame and guide frame were repeated and the reduction of weight was realized (Figure 1).
- (4) The number of parts was significantly reduced by thoroughly unitizing and simplifying the interior components while realizing an impactful interior design.
- (5) Steel materials and steel plates used for interior components were replaced with aluminum castings and aluminum plates to reduce the weight.
- (6) Resinification of seats was promoted for substantial weight reduction while maintaining incombustibility and strength.
- (7) The Train Integrated Management System (TIMS) enabled control by transmission, resulting in the reduction of the number of cables to half or less compared with the conventional number of cables.
- (8) The adoption of a tube seat unit incorporating an IERV (Integrated Electric Relay Valve) electronically controlled brake system reduced the number of air pipes to one-tenth of the conventional number of pipes.

Energy saving effects have been produced by:

- (9) The improvement of the efficiency of the air conditioning system, making the vehicle interior temperature uniform
- (10) The improvement of the insulating efficiency
- (11) The adoption of LED lighting in vehicle

4. Future developments

In “Yurikamome 7300 Series” carriages, the transportation volume was increased by thorough weight reduction without an increase in the number of carriages. Other new AGT system operators can also obtain significant management improvement effects through introduction of the new carriages. For the first time for new AGT system carriages, places for hand baggage were

increased by the full-fledged adoption of baggage racks and space under seats to relieve congestion. Also for the first time, air conditioning ducts (Figure 4) were adopted and a seat design (Figure 2) that imparts a new impression of the carriage was adopted. Various efforts have been made with the intention of providing a comfortable environment. The seat has a characteristic design with a bucket shape and a backrest inclined backward by 15 degrees, thereby securely holding the whole passenger's body and reducing fatigue. Furthermore, by inclining the seat, the passenger's legs cannot be easily stretched out forward, and the seat design is highly rated as a design for inducing good train manners.

The "Yurikamome 7300 Series" carriage was selected among the "Best 100" in the "Good Design Awards 2014" and received a special award as a wonderful design for renovated public transportation. The debut of the "Yurikamome 7300 Series" carriage, with functions that differ from those of existing AGT systems, has attracted the attention of new AGT system operators, we have already received orders for the same Series from two operators, one is Tokyo Metropolitan Government for Nippori-Toneri Liner and the other is Saitama New Urban Transit Co., Ltd. for New shuttle, and the carriages have entered into operation.

5. Conclusion

The use of a variable seating arrangement on the "Yurikamome 7300 Series" carriage, which was made possible by the reduction in weight, resulted in the passenger capacity being expanded by more than 10% due to the increased standing area. Furthermore, passengers can now smoothly board, disembark and move within the carriage. The operators highly appreciated the profound effect of increasing the transportation volume.

The area along the Yurikamome line is the venue of the 2020 Tokyo Olympic and Paralympic Games, and it must maintain high reliability as a means of mass transportation for spectators. Therefore, since the operation of the new carriages started in January 2014, MHI, together with the operator, has been making efforts to further improve reliability through periodical inspections.

The high level of design of the front part (Figure 6), which has improved visibility so that people coming to the Tokyo Waterfront area from all over the world can enjoy the view, the exterior (Title photo) and the interior (Figure 2) have all become benchmarks for future AGT carriages. We will continue to make proposals so that many people can board the "Yurikamome 7300 Series" carriages and many cities around the world will consider the introduction of the new AGT system as a solution to their transportation problems.