High-speed Automated Guideway Transit System

MITSUAKI HOSHI*1 MASAHISA MASUKAWA*2

ICHIRO JOREN*3 SO TAMURA*4

KEISUKE KIMURA*4 YUKIHIDE YANOBU*5

Mitsubishi Heavy Industries, Ltd. (MHI) has developed a high-speed automated guideway transit (AGT) system with a maximum speed of 120 km/h, which is approximately twice as fast as existing AGT systems. The high-speed AGT system, as a result of a newly-developed high-speed bogie, attains not only increased speed, but also further reduction of vibration and noise. Its sophisticated exterior design that gives the impression of speed, coupled with an interior design filled with urban sensibility, heralds the next-generation AGT system. This paper describes vehicles of the high-speed AGT system.

1. Introduction

Automated guideway transit systems using rubber tires have been introduced around the world due to the advantages of flexibility in route planning, low construction cost, shorter construction period, low operation cost, and low vibration and noise. However, the maximum operation speed of the conventional AGT systems of both MHI and its competitors is 60 km/h (in Japan) to 80 km/h (overseas), and therefore they are positioned as medium capacity urban transportation systems. The high-speed AGT system with a maximum speed 120 km/h has been developed in order to expand the market for high capacity urban transportation systems including suburban lines, while maintaining the superb technological characteristics of this medium capacity urban transportation system.

2. Background

In comparison to ordinary railroads, an AGT system that runs on rubber tires can travel through tighter curves and steeper slopes, and therefore allows for higher flexibility in route planning. In addition, due to its smaller environmental load such as lower vibration and noise in travelling, the AGT systems are widely introduced domestically and abroad as transportation infrastructure between airport terminals and urban transportation systems such as feeder (branch) lines in urban areas. For many such AGT systems, an unmanned, fully-automatic operation system is introduced.

Figure 1 shows the area covered by AGT systems among tracked transportation systems. Because of their purpose, existing AGT systems are used for routes where the distance between stations is as short as around 1 km and the maximum train travelling speed is 60 km/h (in Japan) to 80 km/h (overseas). Therefore both the schedule speed [Note 1)] and the transportation capacity of existing AGT systems are smaller than iron-wheeled systems.

Note 1) The schedule speed is obtained as the travel distance divided by the travel time including stopping periods at stations

*1 Deputy Director, Vehicle Department, Land Transportation Systems Division, Commercial Aviation & Transportation Systems
*2 Land Transportation Systems Division, Commercial Aviation & Transportation Systems
*3 Chief Staff Manager, Vehicle Department, Land Transportation Systems Division, Commercial Aviation & Transportation Systems
*4 Vehicle Department, Land Transportation Systems Division, Commercial Aviation & Transportation Systems
*5 Hiroshima Research & Development Center, Technology & Innovation Headquarters

For emerging regions such as Southeast Asia, the introduction of AGT systems is expected to be an effective solution to traffic congestion in urban areas caused by rapid economic development. However, increasing the speed of AGT systems is necessary in order to enable not only urban transportation, but also transportation to suburban areas without transferring. As a result of the development of the high-speed AGT system with a maximum speed of 120 km/h, both the average speed (including stopping periods) and the transportation capacity can be enhanced significantly. Accordingly, MHI can now offer a system that can compete with iron-wheeled systems.

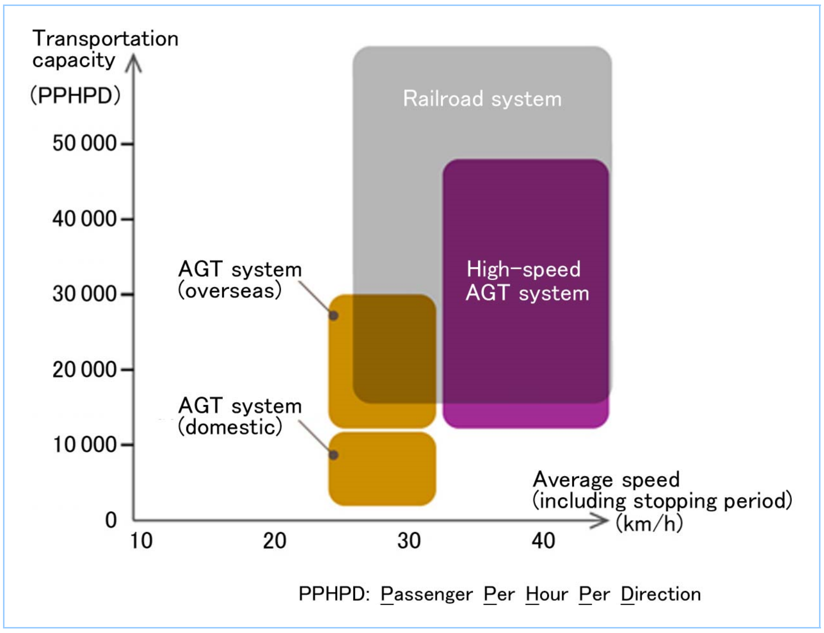


Figure 1 Area classification drawing of track transportation systems

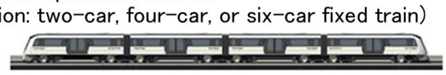
3. Specifications and features of high-speed AGT system

Table 1 shows the specifications of the high-speed AGT system developed by MHI. The developed train configuration consists of one car, but optionally a two-car, four-car, or six-car train can be used, so that train operation optimized for the railroad route on which the system is to be introduced can be offered.

Table 1 Specifications of high-speed AGT system

Vehicle data

Train composition: One car
(option: two-car, four-car, or six-car fixed train)



(Four-car fixed train)

Vehicle specifications and weight (one car)

Length	13,330 mm
Width	2,775 mm
Height (from travelling surface to top of roof)	3,800 mm
Side door opening width	1,850 mm
Wheelbase (between tire centers)	8,200 mm
Tread	2,000 mm
Guide track width	3,200 mm
Empty weight	14,800 kg
Full-load weight (200% of seating capacity)	23,200 kg

Performance and capacity

Design maximum speed	120 km/h
Maximum acceleration	3.5 km/h/s
Deceleration (common maximum)	3.5 km/h/s
Deceleration (emergency maximum)	4.5 km/h/s
Minimum radius of horizontal curve	30 m
Maximum slope	10%
Seating capacity (according to JIS E 7103)	77
Full load (200% of seating capacity)	153

Technological features

Electrical mode	DC750V
Electric equipment	AC inductive motor
	VVVF control
	Third rail, Side contact type
Train guiding type	Side guiding type
Train operation system	Automatic operation with automatic train operation device

Figures 2 and 3 show the exterior view of the high-speed AGT vehicle, and **Figures 4, 5 and 6** show the interior. The sophisticated exterior design fully reflects the high rate of speed that can reach a maximum of 120 km/h, and also takes the reduction of air resistance into consideration. The interior design is filled with urban sensibility and can be selected from the two types, the cross-seat layout that offers a comfortable sense of speed in unmanned, fully-automatic high-speed operation, and the long-seat layout for commuter trains that provides a more comfortable experience for more passengers.

To enable unmanned, fully-automatic operation with a maximum speed of 120 km/h, which is approximately twice as fast as existing AGT systems, development was undertaken in various aspects. In particular, the development of the bogie, which determines the main functions of a vehicle including running, stopping and turning, was a main focus (**Figure 7**). The following three points were the development focus of the high-speed bogie:

- Safety
- Ride comfort at high speed
- Economic efficiency

For safety, a new braking system that has sufficient braking force and thermal capacity for high-speed braking has been developed. For ride comfort at high speed, a new suspension system that enhances road followability of the tires has been adopted. For economic efficiency, the track travelling rubber wheels, which account for a large percentage of the operation and maintenance cost, have been designed so that commercially available standardized truck/bus tires can be used in consideration of both high-speed travel and economic efficiency in the replacement of worn tires.

In addition to the above, new power collectors that can collect electric power stably from the electric car line on the track – even at high-speed travel – have been adopted, and the guide wheels that follow the guide track have been enlarged.

Figure 2 Exterior view

Figure 3 Exterior view

Figure 4 Interior (long seat layout)

Figure 5 Interior (cross seat layout)

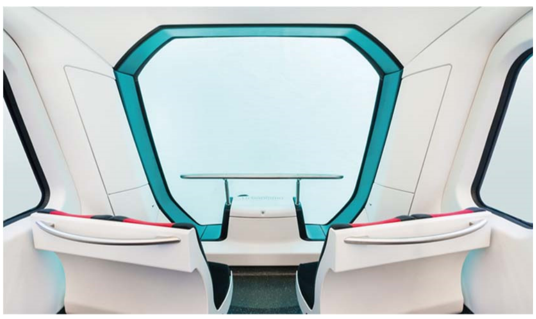


Figure 6 Interior (panorama seat)

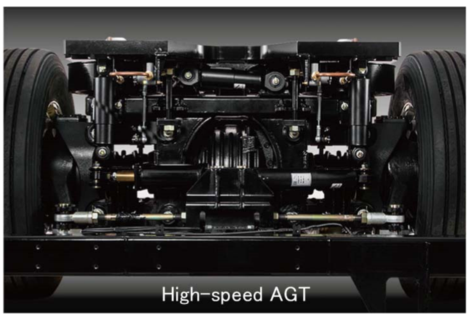


Figure 7 Bogie

4. Future progress

Currently, the high-speed AGT vehicle is undergoing various running tests successfully at the Mihara Test Center, which is a general transportation system test facility at the MHI Mihara Machinery Works in Mihara City, Hiroshima prefecture. Through test runs at the Mihara Test Center under conditions similar to actual operation, in addition to various strength analyses and motion simulations with the aid of computers and tests of lone components on a chassis dynamo device, earlier practical application of new technologies and new systems is promoted. Moreover, data acquisition and evaluation can be performed according to the specifications and standards requested by customers.

In addition, the development, design, and verification of the high-speed AGT system have been undergoing simultaneous safety evaluation by a third party organization in order to establish a development process for the creation of an even safer system.

MHI has marketed airport automated people mover (APM) products under the brand name of Crystal Mover, as well as urban AGT products under the brand name of Urbanismo, widely in the U.S., Asia, and the Middle East. MHI has already established its position as a leading manufacturer in the global AGT market. We will further focus on increasing orders for urban transportation systems by putting this high-speed AGT system on the market.

5. Conclusion

MHI has developed a high-speed AGT system with a maximum speed of 120 km/h, which is approximately twice as fast as existing AGT systems, and yet retains the conventional advantages. Based on the increased speed attained in this development, MHI will offer the high-speed AGT system as an effective solution to various problems including traffic congestion in cities caused by rapid economic development in emerging regions such as countries in Southeast Asia.