Abstract

The running tests of the MLX01 superconducting Maglev vehicles on the Yamanashi Maglev Test Line are now in the fifth year. These tests began in April 1997. The designed maximum speed of 550 km/h was attained about nine months later. Tests to confirm the overall function of the Maglev system were conducted in the second year of testing, and tests to confirm the reliability and durability of the system started in 1998. In the third year, a maximum speed of 552 km/h was attained with a manned five-car train set, which was registered as a Guinness world record. Tests of two trains passing each other were also carried out at a relative speed of 1,003 km/h.

Based on the results of these three years of vehicle running tests, the Technical Evaluation Committee of the former Ministry of Transport, (currently the Ministry of Land, Infrastructure, and Transport) assessed in March 2000 that this Maglev system was technologically feasible as a super high-speed mass transit system, with the exception of a few issues that require further examination. The Committee also concluded that the vehicle running tests should be continued for another five years to strive for technical completion.

According to the recommendation of the Committee, plans for the tests to be conducted until 2005 have been laid out, aiming at proving the reliability and durability of the system, cost reduction and clarification of vehicle aerodynamic characteristics. This paper reports the current status of the vehicle running tests on the Yamanashi Maglev Test Line, and discusses the development of technology to be carried out in the new phase.

1. Introduction

JR Maglev has remarkable features of high speed in addition to the capability of mass transportation, stability, safety, punctuality, and environmental friendliness equivalent to that of conventional railways. RTRI and JR Central have been developing this innovative system as a new mode of transport for the 21st century. The vehicle running tests started in April 1997 and steadily
progressed to attain a speed record of 552 km/h. A high-speed test of two trains passing each other at a relative speed of 1,003 km/h, and running tests of a five-car train set were also successfully carried out without experiencing any serious problems with the “MLX01” test vehicles during these four years. The development of JR Maglev is now being promoted further under a new five-year test plan which was implemented in 2000 to aim for the completion of the technology.

2. Outline of the tests in the first three years

(1) Target of the technical development

The verification of three major issues was set as a target at the beginning of this project. The first issue is the performance at high speeds of over 550 km/h, which is 10% higher than the maximum speed for revenue service in the future. The second issue is punctuality and the capability to transport over 10,000 passengers per hour in each direction, which is necessary for mass transport between Tokyo and Osaka, the two largest cities in Japan. The third issue is profitability and the reduction of construction and operation costs.

(2) Outline of the results of tests

a. Basic running tests

The basic performance was verified by using one train set in tests which included wheel-supported running at lower than 200 km/h, characteristics of magnetic levitation up to 550 km/h, stability of vehicles, speed controllability, performance of brakes, etc.

b. General function tests

Various tests were carried out to verify the general functions which are necessary for commercial operation, such as multi-train control, and switching-over between substations. Dynamics of two vehicles passing each other at a relative speed of up to 1,003 km/h was also verified using two train sets. In addition, full-active and semi-active vibration control systems were tested in order to improve the riding comfort.

c. Reliability verification tests

High-speed running tests at over 400 km/h were performed repeatedly to verify the reliability of the system.

(3) Evaluation by the Technical Evaluation Committee

In March 2000, the Technical Evaluation Committee of the former Ministry of Transport (currently the Ministry of Land, Infrastructure, and Transport) evaluated the development and test results of JR Maglev mentioned above, and concluded that from technical aspects, the system seems to have reached a substantial level of practicality as an ultra-high-speed mass transport system, with the exception of certain issues of the durability and economy of JR Maglev that require further examination. The Committee pointed out the following issues that should be examined:

a. Reliability and durability

b. Cost reduction

c. Improvement of the aerodynamics of vehicles
Table 1 Schedule of the first three-year test period

<table>
<thead>
<tr>
<th></th>
<th>1997</th>
<th>1998</th>
<th>1999</th>
<th>2000</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Basic Running Tests</td>
<td>General Function Tests</td>
<td>Reliability Verification Tests &amp; Other Verification Tests</td>
<td></td>
</tr>
</tbody>
</table>

3. Schedule of tests after 1999

According to the recommendations of the Committee, an additional five-year test plan beginning in 2000 was adopted. Table 2 shows the schedule for the new plan.

Table 2 Five-year test plan

<table>
<thead>
<tr>
<th>Fiscal Year*</th>
<th>2000</th>
<th>2001</th>
<th>2002</th>
<th>2003</th>
<th>2004</th>
</tr>
</thead>
<tbody>
<tr>
<td>Confirmation of Reliability and Durability</td>
<td>High Speed Running Test</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Improvement of Cost Performance</td>
<td>Ground Coils</td>
<td>Confirmation on Test Line</td>
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<td></td>
<td>Power Converters</td>
<td>Confirmation on Test Line</td>
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<tr>
<td></td>
<td>Power Supply Systems</td>
<td>Confirmation on Test Line</td>
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<tr>
<td></td>
<td>Guideway Construction</td>
<td>Confirmation on Test Line</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Improvement of Aerodynamic Characteristics</td>
<td>Design and Construction of New Vehicles</td>
<td>Confirmation on Test Line</td>
<td></td>
<td></td>
<td></td>
</tr>
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<td></td>
<td>Data Collection</td>
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</tbody>
</table>

*Japanese fiscal year: April to March

4. Major results in 2000

The high-speed vehicle running tests were performed repeatedly in 2000 to evaluate the durability and reliability of the system. Numerous trial rides by VIPs and selected public applicants were also held. In addition, various tests were also conducted to acquire data which were necessary for the examination of new development that began in 2000.

(1) Repeated high-speed vehicle running tests

The cumulative distance traveled by the MLX01 vehicles since the beginning of the running tests is shown in Fig. 1. This diagram shows that the distance traveled after March 2000 exceeds 79,000 km, accounting for more than half of the total distance traveled. As mentioned above, the repeated running test was intensively conducted in 2000 to attain this result. Further information is shown in Table 3.
Table 3 Results of traveling distance (as of July 13, 2001)

<table>
<thead>
<tr>
<th>Results</th>
<th>Notes</th>
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</thead>
<tbody>
<tr>
<td>Distance traveled after March 2000</td>
<td>79,690 km</td>
</tr>
<tr>
<td>Days of running after March 2000</td>
<td>204 days</td>
</tr>
<tr>
<td>Cumulative traveling distance</td>
<td>155,117 km From the beginning of the tests</td>
</tr>
<tr>
<td>Maximum distance traveled per day</td>
<td>1,029 km December 7, 2000</td>
</tr>
</tbody>
</table>

Fig. 1 Cumulative traveling distance

(2) Trial rides

Trial rides were held for the first time in May 1998. Since then, trial rides for VIPs have been held repeatedly. Since August 1999, selected public applicants have also been invited for trial rides to make the cumulative number of passengers reach 20,000 in June 20, 2001. Table 4 and Fig. 2 show the data of passengers who experienced trial rides on the MLX01 vehicles.

Fig. 2 Cumulative number of MLX01 passengers


<table>
<thead>
<tr>
<th>Number in FY 2000</th>
<th>Passengers</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cumulative number</td>
<td>20,476</td>
<td>As of July 13, 2001</td>
</tr>
</tbody>
</table>

(3) Improvement of riding comfort

Semi-active dampers in the bogie and realignment of the guideway were tested in order to improve the riding comfort of MLX01. Both methods have indicated improvement.

(4) Data collection for designing new vehicles

Various data for designing new vehicles were collected during the running tests in 2000.

5. New technologies to improve the JR Maglev system

Based on the recent technical developments that began in 2000, some new technologies will be introduced on the Yamanashi Maglev Test Line in 2002, which will contribute to the acquisition of important data for further development.

(1) New types of vehicles

New vehicles will be introduced on the test line. One type is a leading car which is shown in Fig. 3 below. The nose shape is experimentally designed to be as elongated as possible in order to verify the effects on aerodynamics. The other type is a middle car which is a prototype for revenue service.

(2) New type of guideway

On the Yamanashi Maglev Test Line, there are three types of guideway which differ in the structure of the sidewalls and in the method of installing ground coils. The three types have different merits. The new guideway being developed has sidewalls with a cross-sectional shape of an "inverted T" as shown in Fig. 4 (the left and right sidewalls are shaded in darker gray). It excels over the conventional types of guideway in terms of weight, cost, and facilities for construction and maintenance.

(3) New type of ground coils

A new type of ground coils to be attached to the sidewalls of the guideway in a single-layered arrangement is under development, which differs from the double-layered arrangement currently being used on the Yamanashi Maglev Test Line. The single-layered arrangement can reduce the costs.
of manufacturing and installation because it results in a reduced number of necessary coil types and also reduced coil size. This new type of coils will be installed on the aforementioned new type of guideway.

![Fig. 4 A new type of guideway](image)

(4) High-efficiency converters

Power converters using IEGTs (Injection Enhanced Gate Transistors) instead of GTOs (Gate Turn-off Thyristors) are under development. IEGTs can realize high efficiency and smaller size of converters because their characteristics simplify the peripheral devices such as snubber circuits and protection circuits.

6. Conclusion

The running tests of the MLX01 vehicles on the Yamanashi Maglev Test Line are being carried out according to schedule without encountering any serious problems. The maximum distance traveled per day is over 1,000 km and the cumulative distance traveled exceeded 150,000 km. In addition, technical development to improve the system has steadily progressed. It is planned to introduce new technologies in to the Yamanashi Maglev Test Line in 2002 and their performance will be verified by vehicle running tests.

Acknowledgment

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References