The Status of the running tests of JR-Maglev

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Abstract

JR-Maglev is developed to be applied to the new artery between Tokyo and Osaka. Its basic performance and various functions have already been confirmed through the running tests on the Yamanashi Maglev Test Line by 2000. At present, the running tests are continuously conducted in order to verify its durability and reliability and to upgrade its performance with new technologies. It is aimed to complete the technology necessary for the revenue service by March 2005. This paper deals with the status of the running tests of JR-Maglev including the new speed record achieved last year and new equipments introduced to the test line recently.

1 Schedule and status

1.1 Outline of the test schedule

JR-Maglev has been developed for an innovative transportation system in the next generation. It adopts an electro-dynamic levitation system and synchronous motors using superconducting magnets. This system is expected to be applied to the Chuo Shinkansen, the new artery between Tokyo and Osaka which are the biggest cities in Japan.

The running tests on the Yamanashi Maglev Test Line (YMTL) have been conducted for eight years since April 1997. The eight years comprise two phases. The first phase was three years from April 1997 to March 2000, and the second is five years from April 2000 to March 2005.

In the first phase, various tests were carried out in order to verify the basic performance and the various functions of this system for the revenue service. These tests included speed-up tests up to 552 km/h, multi-train control tests, passing tests, durability and reliability tests, and so on.

At the end of this phase, the technical practically evaluation committee of the former Ministry of Transport of Japan concluded, “JR-Maglev has the practicality for ultra-high speed mass transportation system.” The committee also pointed out the necessity of further running tests for the following improvements:

(1) Evaluation of durability and reliability
(2) Cost reduction of its construction and operation
(3) Improvement of the aerodynamics of vehicles for environmental impacts

According to these recommendations, the second phase was projected as shown in Table 1 to improve these technical issues.

A lot of new facilities were developed and tested on their performance on the YMTL. Repeated running tests have also been conducted to evaluate durability and reliability.

The committee made an intermediate evaluation in May 2003 as “Technical developments have been steadily progressing for the revenue service.” They also reported that it was necessary to make the technical guideline for the revenue service and to design equipments for the practical commercial line.

This year is the last year of the second phase. It is aimed to complete the JR-Maglev technology necessary to realize the revenue service.

Table 1 Test plan of the second phase

Fiscal Year*	2000	2001	2002	2003	2004
Evaluation of Durability and Reliability	High Speed Running Test				
Improvement of Cost Performance	Ground Coils			Confirmation on Test Line	
	Power Converter			Confirmation on Test Line	
	Power Supply System			Confirmation on Test Line	
	Guideway Construction			Confirmation on Test Line	
Improvement of Aerodynamic Characteristics	Design and Construction of New Vehicles			Confirmation on Test Line	
	Data Collection				

*Japanese fiscal year: April to March

1.2 Cumulative distance traveled

The running tests are being carried out on about 160 days per year. Cumulative distance traveled reached 370,000 km as of the end of May 2004. Fig. 1 shows the progress of the distance since the beginning of the running tests. The distance increased year by year in the first three years and is more than 70,000 km in recent years. This means the running test for verifying durability and reliability is intensively carried out in these years. The detail information is shown in Table 2.

Table 2 Results of traveled distance (as of June 11, 2004)

	Results	Notes
Cumulative traveled distance	371,333 km	From the beginning of the tests
Distance traveled since April 2000	295,905 km	
Maximum traveled distance a day	2,876 km	November 7, 2003

1.3 Test ride

The first test ride of JR-Maglev was held in May 1998. Fig. 2 shows the growth of the number of passengers. This chart shows the passengers increased rapidly from April 2003. This is the reason the new four-section train set got applied to the test ride in stead of the older three-section train and doubled the capacity. At the same time, the top speed for test rides was raised to 500 km/h from 450 km/h. More than 70,000 people enjoyed the ride of JR-Maglev so far.

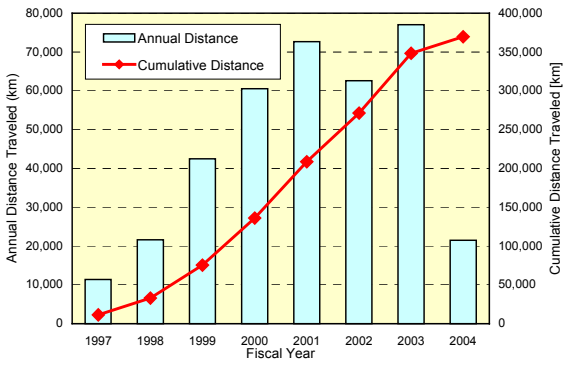

Fig.1 Progress of distance traveled

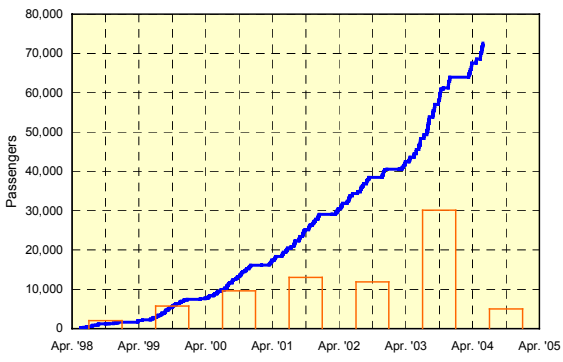

Fig. 2 Progress of passengers

2 Recent test results

2.1 Further speed-up test

JR-Maglev set a new world speed record of 581 km/h on December 2, 2003. Fig. 3 shows the running profile. The distance for acceleration was about 8,600 m and the time was about 90 seconds. The top speed lasted for 900 m and 5.6 seconds. The average of the acceleration to the top speed was 1.51 m/s^2 (5.44 km/h/s), and the maximum is about 2.7 m/s^2 (9.72 km/h/s). This is much higher than those of other high speed transportation systems.

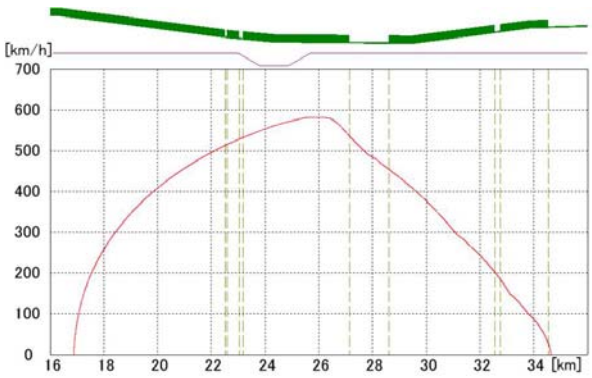

Fig. 3 Running profile of 581 km/h

The speed of 581 km/h was achieved twice on the day. The running was very stable and no problems were found though 581 km/h is 30 km/h higher than the designed speed of the YMTL. This result shows the high reliability and safety of this system.

2.2 Endurance running test

The traveled distance per day in the revenue service is estimated to be about 2,500 km. In order to verify no trouble would occur in traveling more than 2,500 km a day, an endurance test was planed. This test was carried out twice on October 31 and on November 7, 2003. Running tests were repeatedly conducted from seven in the morning to nine in the evening, and the distance reached 2,524 km and 2,876 km respectively. These results are two times longer than the distance recorded before.

The test line is only 18.4 km long and the train had to start, stop, take off and land every 16 km, therefore, the condition of this test was more severe for some facilities such as landing gears and ground coils than that in the revenue service in some respects.

3 New technologies

According to the recommendation of the committee mentioned above, various kinds of technical developments have been executed for the improvements of this system for the revenue service. Through these developments, new technologies have been introduced to the YMTL so far. The followings are some examples of them.

3.1 New vehicles

Two new vehicles, shown in Fig.4, were introduced to the test line in July 2002. One is a leading car, and the other is a middle car. These vehicles have many enhanced equipments, but the most characteristic feature is its nose stretched as long as possible experimentally to 23 m. Its rectangular cross section is also a major difference from the round shape of the original vehicles. These modifications have great effects on improving aerodynamics and reducing air vibration when entering tunnels.


Fig. 4 New vehicles

These vehicles reached their designed speed 550 km/h in only eleven days and this fact proves the way to design is adequate and established. Their cumulative distance has exceeded 80,000 km.

3.2 New sidewalls

New type sidewalls, called “free-standing RC sidewalls” were settled on the test line in September 2002, which were easier to install and to maintain than original types of sidewalls. Additionally, further improved sidewalls were developed in February 2004. This is made of reinforced powder concrete (RPC), so that the thickness is only 7 cm and it is 40 % lighter than conventional sidewalls. This lightness contributes not only to the cost reduction of settlement but also to simplicity of substructure of viaduct.

Fig. 5 Free-standing RC sidewall

Fig. 6 Lightweight RPC sidewalls

3.3 New ground coils

In order to simplify the original double-layered propulsion coils, two types of single-layered propulsion coils were developed and installed to the YMTL. One is an integrated type of coil, which has a propulsion coil and a levitation coil in it. (Fig. 7) This coil can reduce the number of coils to one third of the conventional types. The other consists of cable. (Fig. 8) It is aimed to reduce production cost using power cable whose producing method has already highly established. It is confirmed that both types of coils fulfill their functions as designed without problems.

Fig. 7 Integrated type coils

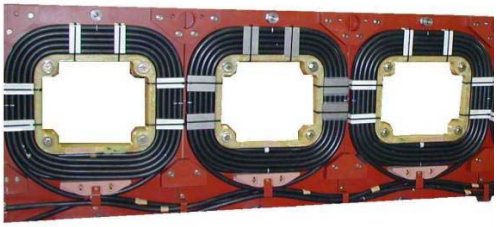

Fig. 8 Cable type coils

4 Conclusion

The running tests of JR-Maglev have been carried out without serious problems for more than 7 years. In addition to the running tests, various technical developments have made a steady progress to upgrade the system. As the results of these tests and developments, the technology of JR-Maglev necessary for revenue service will be completed by next March. This means JR-Maglev is able to be applied to the Chuo Shinkansen at any time if its construction is decided.

These technical developments are partly subsidized by the Japanese government.

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