

THE FIRST URBAN MAGLEV TRANSPORT APPLICATION IN JAPAN

(*) Syunzo ISHIMOTO, (**) Masato KATO

(*)Executive Director of Aichi Rapid Transit Co.

(**)Civil Engineering Manager of Aichi Rapid Transit Co.

1533-736 Ibaragabasama, Kumabari, Nagakute-cho, Aichi-gun, Aichi, 480-1101, Japan

Telephone: +81-561-61-4781 / Fax number: +81-561-61-6221

e-mail address: soumu@linimo.jp

URL: <http://www.linimo.jp/>

Abstract

The Tobu Kyuryo Line (popular name "LINIMO") adopts HSST (High Speed Surface Transport) vehicles of normal conductive magnetic levitating, linear induction motor propulsion system which lifts the body by magnetic attractive force of electromagnets, makes the train drive with linear motors. And it is the first practical usage route of the extension about 9km by the magnetic levitating type transportation system in Japan.

The demand forecast, the revenue and expenditure plan, the outline of the vehicle design and train depot and the barrier-free devices in the station buildings in the Tobu Kyuryo Line under construction now are introduced in the following sections of this report.

1 Introduction

An eastern hillside region in Nagoya is planed as "Aichi Academic Research and Development Zone" and the overall regional development including the enhancement of the residence, the culture, and the recreation function etc. is promoted in this area. On the other hand, this region in Nagoya is lack for a system such as iron orbit high-speed conveyance, the dependency to the motor traffic is very high and the congestion such as the trunk line roads is also remarkable.

Therefore the necessity of the urban traffic organization of the iron orbit system or something like that has risen for the further development in this hillside region in Nagoya city.

In such a background, in January, 1992 the transportation policy council of the former Ministry of Transport announcement reported the Tobu Kyuryo Line was assigned as "a suitable route to be going to fabricate a middle-sized orbit transit system by 2008", and "Aichi Rapid Transit Co." which was the management subject of the railway business in the Tobu Kyuryo Line was established in 2000.



Figure 1.1: Vehicle

Concerning selection of vehicle system, the local government model selection committee examined and discussed each other the adaptability of the route characteristic, an economy, and regional maintenance about three different models (that is, the new transportation system, the holding type monorail and the magnetic levitating system), and finally decided to select the magnetic levitating type (HSST) system. In addition, this Tobu Kyuryo Line is treated as a spectator transportation means of the World Exposition in Aichi because along it the Aichi youth park is located, which becomes the main site of " the 2005 World Exposition, Aichi, Japan " held in March, 2005.

It is considered to be a splendid chance for the magnetic levitating type system of the Tobu Kyuryo Line to expand this high technology to the world.

2 Demand forecast

2.1 Forecast method

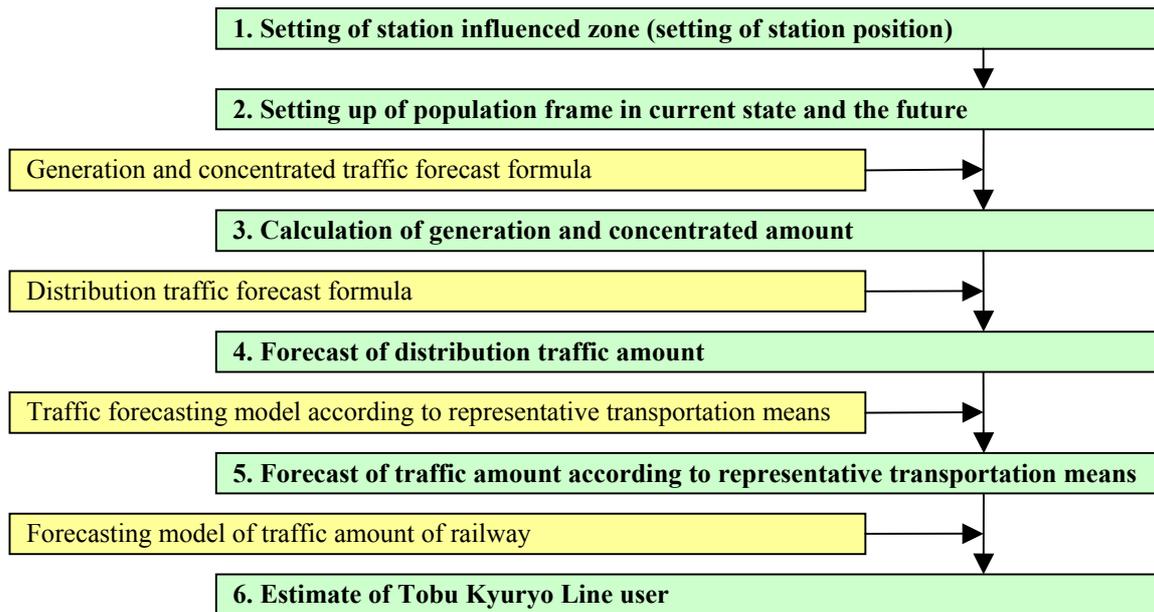
The demand forecast for the Tobu Kyuryo Line uses the questionnaire survey which estimates person's movement by 3rd Chukyo city area person trip investigation conducted in 1991. Additionally it also consists of the setting of the zone which shows regional division, the population grasp in the zone and the estimate traffic volume in the future using by four stage presumption method.

Concerning the setting of the zone, in order to forecast detailed demand for each station, the zone at each city town level of PT (Person Trip) was subdivided to the station influenced zone in which the station is almost the center of this area.

About the population in the zone, it piled up by the census result of the execution in 1995, this was assumed to be a population at the current state. And also the increment of the readjustment of town lots of the eastern hillside area etc. was additionally piled up, and the population frame was calculated in the future of three years of 2005, 2015 and 2025.

Based on these population frames, using by four stages estimation, that is, the traffic number of going in and out of each zone (generation concentration amount), the number of trips between zones (distribution traffic amount), the representative traffic number moving on foot, by the car, by the railway, and by the bus (representative traffic amount according to the different transportation means) and the expected traffic number of the Tobu Kyuryo Line users (railway use traffic amount) were estimated.

The following is the flow chart of the demand forecast



2.2 Forecast result

	Year 2005	Year 2015	Year 2025	
Population along railway-tracks	83,430	88,619	90,455	
Number of users during all day	31,016	33,831	34,373	
The number of users per km	3,485	3,801	3,862	
The section of max. number of users per km	Between Fujigaoka and Hanamizuki-dori stations			
The number of users passing through the max. section	all day	13,420	14,556	14,799
	peak hour	3,395	3,683	3,744

3 Operation plan

The operation plan in the Tobu Kyuryo Line is assumed that the train is three-car fixed train-set, and the operational form is consisted of only all station stopping trains based on the operation between all the line.

Moreover, the maximum loading factor is assumed 150% or less, and if it exceeds the value, the transportation power shall be compensated by the increase of operational frequency in the most congestion section.

Operational form		Un-manned operation by ATO equipments
Business hours		5:30 ~ 24:00
Operational frequency		110 (One way)
Operational interval	Rush hours	6 minutes interval (10 trains/hour)
	During daytime	10 minutes interval (6 trains/hour)
	Early morning and nighttime	15 minutes interval (4 trains/hour)
Operational protection system		ATC
Number of trains		Eight train-sets (24 cars) * including two train-sets for stand-by and maintenance

4 Revenue and expenditure plan

4.1 The basic condition of revenue and expenditure plan

4.1.1 Whole business expense

Infrastructures part	Except for infrastructures	Total
54,000 million yen	36,000 million yen	Approximately 90,000 million yen

* Construction of infrastructures part (pier and girder etc.): Public works (Aichi prefecture and City of Nagoya)

* Construction and management of except for infrastructures part

(vehicle and electric equipments installation, etc.) : quasi-public corporation business

4.1.2 Fiscal resources for business expense of except for infrastructures part

Business expense of except for infrastructures part ; 36,000 million yen				
Contribution (20%) 7,200 million yen		Loan without interest (30%) 10,800 million yen	Loan with interest (50%) 18,000 million yen	
Municipality (51.85%)	Private organization (48.15%)	Municipality (100%)	Municipality (22.75%)	Private organization (77.25%)

4.1.3 Fares

	Fares
Fares for The first ride	About 160 ~ 180 yen
Addition fare of each 2km	About 50 ~ 60 yen
The student pass for (one month)	with about 60% discount

4.1.4 Labor cost and management expenditure after business openings

Workers	72 persons
Labor cost	Approx. 400 million yen
Management expenditure (Maintenance management fee etc.)	Approx. 580 million yen/year

4.2 Revenue and expenditure result

			Annual year	Fiscal year	Amount of money
Revenue and expenditure in profit and loss	Conversion to surplus	Single fiscal year	10 years later after a business opens	Year 2015	—
		Total	23 years later after a business opens	Year 2028	—
	Maximum loss		9 years later after a business opens	Year 2014	Approx. 6,200 million yen

5 Vehicle

5.1 Basic system specification

Train Unit	Fixed 3-car train Total train length: 43.3m
Vehicle Dimension	End Car: 14.0 m length×2.6m width×3.45m height Middle Car: 13.5 m length×2.6m width×3.45m height
Passenger Capacity	Unit: 244 (seated: 104), End Car: 81 (34 / car), Middle Car: 82 (36 / car)
Main Equipment	<p>1 Car Body Structure Welded aluminum structure with emergency end doors 2 entrance doors/side/car (2 directional opening; 1200 mm width)</p> <p>2 Main Devices</p> <ul style="list-style-type: none"> - Suspension System: Flexible multi-module, 5 coupled-modules/car - Levitation and Guidance: Normal conductive with attractive magnetic force for levitation and lateral guidance (levitation height: 8mm) - Propulsion: Linear Induction Motor 10ea/car VVVF Inverter 1ea/car - Braking Device: Service Braking: Electrical braking, hydraulic braking Emergency Braking: Hydraulic braking (regeneration/reverse phase) - Electricity Type: DC-1,500V - Auxiliary Power Unit: DC/DC converter (2 units/unit) - Operation (Automatic Train Operation)
Vehicle Performance	<ul style="list-style-type: none"> - Maximum Operating Speed: 100 km/h - Acceleration: 4.0km/h/sec. - Deceleration: 4.0km/h/sec. at full service braking - Maximum slope-run capability: 60‰ - Minimum curve-run capability (radius): 50m

5.2 Vehicle design

The image of the vehicle externals are based on the design concept that this new vehicles have the sense of relief, brightly for the image as a new transportation system applied to an east part of Nagoya hillside region where there are many kinds of public and private universities, research laboratories and the recreational facilities, etc. and the users will be able to enjoy the route scenery and the design has been advanced cooperated with Aichi Prefectural University of Fine Arts and Music.

5.2.1 Concept of design

◇Suitable design for infrastructure of cultural base:

A simple forming which harmonizes with various route spectacles is pursued.

An extra make-up (decoration and chamfering, etc.) is not used, and it designs by the proven forming based on a functionality and a structural rationality .

Lacquer-ware and filling with a cloth are avoided as much as possible, and design shall be tried by making the best use of the characteristic of the original material.

◇Design of comfortable walking space and street spectacle:

Route and pedestrian's pressure feelings are reduced, sunshiny and ventilation are considered, and it tries to design by the production of lightness and happiness to the street space.

5.2.2 Design concept of vehicle

◇About the vehicle externals:

The design of the front shape is based on the cutting shape and the body with transparent feelings, and body is painted with white as the keynote and symbolically composes blue as a color with a transparent feeling.

In addition, the logotype of Linimo which is the nick name of the route is distributed at the center of the body as the main graphics.



Figure 5.1: Vehicle design

◇Vehicle image:

To express the character in the future as a three-dimensional forming feeling, the ceiling material is composed to be a consecutive surface illumination with the punching material.

The strap is omitted, and moreover, stanshion pole of the interior design which expresses a characterized three-dimensional forming feeling, has been used positively.

The color with the impact is not adopted because the keynote of the inside color dares not to ruin the transparent feeling which tries to be expressed in the vehicle image, and the color with the material feeling like the monochrome system and the metallic system, etc. is coordinated to use.

5.2.3 Selection reason of popular name "LINIMO"

"LINIMO" is a popular name which abbreviates the linear motor car, and the trait of the Tobu Kyuryo Line which is the first application of the magnetic levitation type linear motor car in Japan must be expressed. Moreover, it was adopted as a pet name because it can be called easily and very friendly.

6 Train depot

The Train depot was already constructed with the area of about 3.5ha in the adjoining land of the Aichi youth park. Because the Tobu Kyuryo Line is adopted an automatic train operation system by ATO, the headquarters office and the operational control center are set up in the train depot.

Moreover, the maintenance hanger where inspection and repair of vehicles are conducted, carwashing space for washing and cleaning of the vehicles and parking line for all cars etc. are also fabricated. In addition, two delivery inspection lines where the automatic operational function is examined before the train rolls out are installed to correspond to the automatic operation system.

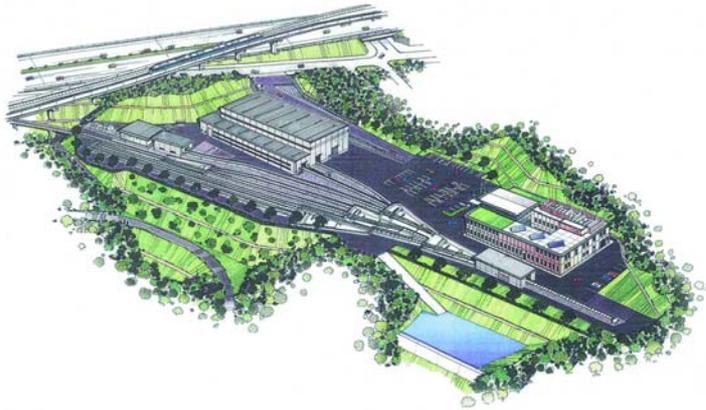


Figure 6.1: Train depot

7 Measures of making to barrier-free at Tobu Kyuryo Line station

The station in the Tobu Kyuryo Line is planned based on the barrier-free transportation law enforced by the Ministry of Land, Infrastructure and Transport in 2000, and advances the design taking consideration as the user in facilities can use it more smoothly as a traveler facilities in the public transportation. As a design policy it is assumed that a standard content of "Smooth making the movement maintenance guideline of the public transportation traveler facilities" is satisfied.

7.1 Passage, the stairs, and elevator

The route (primary line) from the station gateway to the platform is made to satisfy barrier-free requirements by setting up the elevator in the movement of the vertical direction, and assumed to be a structure without the difference basically. Moreover, the block for the audiovisual physically handicapped person inducement is set up on the main route and the audio guidance is also equipped in

the elevator and the escalator. The stairs assume effective width to be 140cm or more, and set up the handrail on both sides by two steps.

7.2 Lavatory

A multifunctional rest room is set up in the lavatory, and the water washing equipment such as pouch and seats for changing the baby diaper are also set up. And additionally at one place in each general rest room for man and woman, the baby chair shall be set up in room for crap. Moreover, the voice guide which informs of by-sex etc is guided in the vicinity of the rest room entrance.

7.3 Ticket vending machine

The main button shall be a structure which can be operated with the height used easily from the wheelchair and the kick protection under the counter which allows to approach the ticket vending machine. Moreover, it is assumed the one that two or more coins can be entered, and sets up the braille fare chart.

7.4 Ticket gate and platform

One ticket gate with the width (90cm or more) which can be used with the wheelchair shall be set up. To prevent the fall into the orbit, the screen and the platform door shall be set up in surroundings of the platform. And the difference and the space between the vehicle floor and the platform shall be taking consideration into getting on and off with the wheelchair. Additionally, the bench for the rest shall be set up in the platform. The sound guide device to inform the position of the ticket gate and the platform upstairs steps shall be set up.



Figure 7.1: Image of platform



Figure 7.2: Image of ticket gate

7.5 Vehicle

The wheelchair space shall be set up respectively in the first vehicle and the tail vehicle.

The guidance indicator which indicates a destination, the next station, and the direction of the door opening and closing shall be installed in the car besides the automatic announcement equipment.

Moreover, when door is opening or closing during passengers' getting on and off the vehicle, attention is drawn with the door chime.

8 Concluding remarks

The Tobu Kyuryo Line is expected to become an important transportation route by which the development of the eastern hillside region, the congestion alleviating of the trunk line road, and the communication strengthening with the Nagoya central area shall be achieved and a helpful part in the transportation of the Aichi Expo is supposed to be played.

The constructing works of this route was started in 2002, and so far there is no accident and little big delay of the construction process and either construction is advanced to this route well though its construction schedule is planned in a very tight period of about three years for the total length approximately 9km.

The author is looking forward to your visit to the Aichi Expo held on March 25, 2005 using the Tobu Kyuryo Line which consists of comfortable and fantastic vehicles for the future by all means.