Study on Planning of New Underground Railway & New Station in The Yaesu-Kyobashi-Nihonbashi District (Part 2)

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Abstract. The Urban Underground Space Center of Japan (USJ), composed of public, private and academic sectors, aims at utilizing urban underground space through various activities like research, study etc. This paper is the second report of the Yaesu-Kyobashi-Nihonbashi Committee USJ’s Three-year project on planning of new underground railway station supposed to be constructed near Tokyo Station once the railway network is to be realized, connecting Tsukuba and Haneda Airport and running through near Tokyo Station, Tokyo Bay Area etc. This research is vital for Yaesu-Kyobashi-Nihonbashi district as many redevelopment projects are carried out vigorously in conjunction with sharp increase in the volume of passenger traffic passing this district.

This time, we mainly report the purpose and role of new underground railway, and the comparative study of route plans. The route plans of A, B and C are compared in terms of the three elements – construction costs, accessibility to the existing Tokyo Station and contribution to revitalization of the district.

As a result of the study, it was suggested that it would be desirable to build a new underground railway under the Chuo-dori street from the viewpoint of town development of this district.

Key Words: Yaesu-Kyobashi-Nihonbashi district, underground railway, railway network, new underground railway station

1. Introduction

The "Future Urban Railways in the Tokyo Metropolitan Area"[1] compiled by the Ministry of Land, Infrastructure, Transport and Tourism (April 2016) takes up the plan of constructing a new subway in the urban and waterfront area, and of extending, as part of this plan, the New Joban Line (Rinkaiibu - Ginza Station - New Tokyo Station - Akihabara Station).

Currently, in the above district, a number of redevelopment projects have been proceeding in recent years and an demand for railway transportation is growing; in order to revitalize the regional community, the Urban Underground Space Center of Japan has FY 2016 to FY 2018 conducted research under the theme of the "New Subway Network and New Station" from the viewpoint of a town building (See Figure 1, 2).

The research has been conducted over the two periods: FY 2016 and FYs 2017 to 2018. The research themes for the first period are: a) necessity for the construction of a new subway, b) benefits and effects from the new subway and c) the issues this district will face by a new railway and a new position status of the district [2]. The research themes for the second period: d)
determination of new three prospective railway routes, e) technological studies of three routes; f) examination of access facilities to new stations’ platforms, g) feasibility and business-derived effects of three routes, and h) comparisons between three routes. Following our report of a), b) and c) at ACUUS 2018, here we report about the topics d) to h).

Figure 1 Network of a new subway

Figure 2 Traffic modality function in the district and its surroundings

2. Setting-up of a New Underground Railway Line
2.1 Conditions for planning the new underground railway

a) Railway track
This project assumes the following conditions.

- Station to station section: this section will be bored by a shield machine, with the same diameter as that of the binocular shield tunnel for the station section.
- Minimum curve radius: 200 m (160 m if inevitable)
  Steepest gradient 35‰; smallest gradient 2‰
- The required separation from other traffic routes or structures will, as a rule, be 1 D (diameter) or more, but if unavoidable, the separation should at least 3 meters or more.
- Under the privately owned ground, the deep underground space is used to lay the railway. When constructing the railway track, careful attention should be paid to the project of relocating the Metropolitan Expressway above the Nihonbashi River.

b) Stations
Along the railway route, two stations will be built: one located near Tokyo Station, a connectivity point between wide-area traffics, and another station located near Nihonbashi (Mitsukoshimae) Station, a connectivity point of local traffic in order to enhance the connectivity between wide-area and local traffics effectively.

- Station section: The station section will be excavated by the binocular type shield
machine (diameter 8.0 m) and a roof shield machine (see Figure 3).

- The station platform is an island type with one lane on each side (see Figure 3).
- Station length 220 m, station’s curve radius 500 m or more, station gradient: 10‰ or less.

The widths of passages and specifications of escalators & elevators are as shown in Table 1.

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**Figure 3** Cross-section of the binocular type shield machine with a roof shield (Mitsukoshimae Station, Hanzomon)

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### Table 1. Width of the passageway and ascending/descending equipment

| **Assumptive number of passengers on the new underground railway and width of the passageway** |
|---|
| The number of passengers on the new underground railway stations are calculated based upon the number of passengers getting on and off nearby subway stations. |
| New Tokyo Station: Number of passengers per day: 200,000 /day |
| Number of passengers at peak hours: 30,000 /hour |
| Nihonbashi Station (Mitsukoshimae Station): |
| Number of passengers per day: 120,000 /day |
| Number of passengers at peak hours: 18,000 /hour |

The widths of the passageways in/out of the station compound (concourse, etc.) are determined from the passenger traffic on the new stations.

- The maximum pedestrian traffic per hour is 5,700 (people/hour • m) for commuter passengers, 3,300 (people/hour • m) for non-commuter passengers.
  - New Tokyo Station: 30,000 (people/hour) ÷ 5,700 (people/hour • m) = 5.3 (m)
  - Nihonbashi Station: 18,000 (people/hour) ÷ 5,700 (people/hour • m) = 3.2 (m)

The width of passageway should be more than 4.0 m.

| **Ascending and descending equipment such as stairways** |
|---|
| 1) Stairways |
| The width of stairway is determined on the condition that the allowable maximum traffic of pedestrians per hour is 4,300 (people/hour • m) in ascending direction, and 5,400 (people/hour • m) in descending direction, and that 80% of the passengers from the new station use the stairways during peak hours. |
  - New Tokyo Station: 30,000 (people/hour) x 0.8 ÷ 4,300 (people/hour • m) = 5.6 (m)
  - Nihonbashi Station: 18,000 (people/hour) x 0.8 ÷ 4,300 (people/hour • m) = 3.2 (m)
| In the case of a disaster, the width of the stairway is designed with a sufficient width so that all the passengers from the fully packed trains (2,000 passengers) are able to evacuate using the stairways within five minutes.
  - Calculation of width for both New Tokyo Station and Nihonbashi Station: 2,000 (passengers) ÷ 4,300 (passengers /hour • m) ÷ 60(min) x 5 min= 5.6 (m)

The width of the stairway at both stations should be determined 6.0 m or more.

2) Escalators |
| The escalators with capacity of 9,000 persons/hour is assumed to be used by all passengers during morning peak hours. |
  - New Tokyo Station: 4 ascending units and 2 descending units |
  - Nihonbashi Station: 2 ascending units and 2 descending units |

3) Elevators |
| 4% of passengers, elderly and disabled, during peak hours, are assumed to use the elevators with a capacity of 675 persons/hour. |
  - New Tokyo Station: 2 units |
  - Nihonbashi Station: 1 unit |
2.2 Overview of three railway route plans

From Akihabara Station to Ginza Station, three underground routes are planned; Route A under the Sotobori-dori street, Route B under Yaesunaka-dori street and Yanagi-dori street and Route C under Chuo-dori street. They are respectively surveyed considering the conditions assigned to the underground railway, and examined in respect of their planar alignments, longitudinal profiles and main cross-sections. Table 2 shows the summary of railway routes and Fig.5 to 7 the plans and longitudinal profiles.

![Figure 4 Plans for the new underground railway routes](image)

**Table 2. Road conditions of Route Plans A, B and C, and overviews of routes and station locations**

| Conditions of current roads          | Overview of the routes                                                                 | Location of the          |
|--------------------------------------|----------------------------------------------------------------------------------------|--------------------------|
| Route Plan A                         | • The route will be constructed under Sotobori-dori                                    | • Since New Tokyo Station is to be constructed keeping a considerable distance from Nihonbashi Station, it will be located between the south end of the Yaesu’s underground shopping mall and Kajibashi-dori. The footpath under the Yaesu’s underground shopping mall will be directly connected with the Kajibashi-dori. | |
|                                      | • Road width of Sotobori-dori 40m, the route passes partially by 27m under Chuo-dori   |                          | |
|                                      | • The ME Yaesu line passes at second underground level under Sotobori-dori (Note: the width south of the Yaesudori is 26m) |                          | |
| Route Plan B                         | • Because the new route is to be laid under a privately owned land between Eitai-dori and northern Chuo-dori, and New Tokyo Station interferes with the private land, the route will be laid deep underground north of the Keiyo Line. | • A passageway is provided at the first underground layer on the Yaesunaka-dori and Yanagi-dori above New Tokyo Station (between Sakura-dori to Kyobashi Nichome Nishi district/Yaesu Nichome Naka district). This passageway is to be provided on the side of the Subway Ginza Line between Nihonbashi Station and Kyobashi Station, which leads to New Tokyo Station. |
|                                      | • Road width of Yaesunakadori and Yanagi-dori 11m                                     |                          | |
|                                      | • From about 80m south of Yaesu-dori, the TEPCO service tunnel of 3,500 in diameter runs north at a depth of about 20m. |                          | |
| Route Plan C                         | • The route will be constructed under Chuo-dori                                        | • New Tokyo Station will be constructed under the Yaesu-dori. |
|                                      | • Road width of Chuo-dori 27m                                                         |                          | |
|                                      | • Currently, the Subway Ginza Line runs at second underground level, and there are three stations, Kyobashi Station, Nihonbashi Station and Mitsukosha Station (width of the station segment about 20m) |                          | |
station (passenger foot traffic line to the platform) traffic passageway will be provided under ME Yaesu Line, and the exits are to be constructed, leading to the bus terminals and the free passageway in the southern Tokyo Station—the Yaesu Underground shopping mall—and to Keiyo Line Concourse. Nihonbashi Station will be constructed under the Nihonbashi River with the exits on the Eitai-dori(Nihonbashi Station) side. 

passageway leads to New Tokyo Station below. The exits are to be provided at Yaesu underground malls and bus terminals. Nihonbashi Station will be constructed deep underground underneath the privately owned land around the Nihonbashi River, providing the exits on the Eitai-dori side and the Chuo-dori side respectively. Considering the Nihonbashi River area is in the proximity to New Tokyo Station, a new station—Mitsukoshimae Station—will be constructed under Subway Ginza Line Mitsukoshimae Station. This passageway exit at Mitsukoshimae Station will be connected to the passageway on Subway Ginza Line.

| 3. Comparison and Review of Three Route Plans |
|---------------------------------------------|
| 3.1 Approximation of project costs |
| For the construction of the stations and the track between Akihabara station to Ginza station, the project cost is calculated on the condition that the shield tunnel be bored with a same outer diameter of 8.0 meters and that the binocular type roof shield be used for the construction of the station segment—an island type station with a roof above. The survey of this time was made upon an approximately same calculation condition that the Route Plans A, B and C are respectively 3.6 kilometers long and have three stations on the route at the same depth of 20 meters to 40 meters. The calculation unit used is verified referring to the "Economic Rationality of the Use of Deep Underground Space for Public Utilities" (Autumn 2001 Report on Transport Policy Studies) and complementally by the use of general contractors’ materials. The project cost is calculated according to the following categories: direct construction costs (interstation track, station, and shafts), costs for tracks, electricity and construction, overheads (as 1/3 of direct construction costs), land costs (sectional surface rights costs for private lands at shallow depths). 

Figure 5 New underground railway route (Route Plan A)
As a result, the total cost between Akihabara and Ginza is approximately 117 billion yen as shown in Table 3 for each route plan, assuming that the difference in depth direction is minor.
Table 3. Approximate project costs for route plans A, B and C (Billion yen)

| Section                  | Direct construction costs | Track, electricity, construction and overheads | railway land costs | Total   |
|--------------------------|----------------------------|-----------------------------------------------|-------------------|---------|
| Akihabara-Ginza section | 68.0                       | 22.4                                          | 26.5              | 117.0   |

3.2 *Required traveling time and accessibility*

Accessibility is quantitatively calculated by multiplying the number of users by reduction in required traveling time. Currently, the number of users per each route is unknown. So, the three Route Plans A, B and C are to be compared to each other in respect to the transfer time from Shin Tokyo Station platform to Shinkansen Tokyo Station ticket gate as well as their monetary conversion per person.

a) *Specific traveling time*

The horizontal walking speed is set at 80 m/min and the vertical movement speed by the escalator is 15 m/min.

b) *Monetary conversions of required traveling times*

For the hourly evaluation value, the value of 43.2 yen/min per person is adopted —value per person relating to business entities in Tokyo metropolitan area which employ 5 regular employees or more—. As a result, the traveling times and money conversion values of Route Plans A, B and C are as shown in Table 4.

Table 4. Travelling times and monetary conversion values of route planes A, B and C

|                               | Route Plan A | Route Plan B | Route Plan C |
|-------------------------------|--------------|--------------|--------------|
| Horizontal distance (m)       | 270          | 340          | 470          |
| Vertical distance (m)         | 50           | 50           | 23           |
| Travelling time (min.)        | 6.71         | 7.21(walking on moving sidewalk) | 6.61(walking on moving sidewalk) |
| Monetary conversion (yen/per capita) | 289.9   | 311.5(ditto) | 285.6(ditto) |

3.3 *Contribution to district revitalization*

The Route Plans A, B and C are compared mainly from the viewpoint of community development, especially from the contribution degree to the revitalization of the district. In this context, the Route Plans A, B and C are compared for the following review points: connecting hub function to nearby stations, potentiality for integral redevelopment of this district, relevancy with the district’s future goals, and development for community town building. The results thereof are shown in Table 5.

4. **Conclusion**

As a result, our Committee, from the viewpoint for revitalization and development of the district, proposes a plan for a new underground railway route under Chuo-dori street, and for constructing two of three underground stations—one under Yaeusu-dori street and the other under Mitsukoshimae Station. In the future, based upon this report, we will present a proposal to the
related organizations, hoping that this recommendation be reviewed and studied further toward the realization of the new underground railway.

Table 5. List for the Comparison of Route Plans A, B and C

| Route Plan A | Route Plan B | Route Plan C |
|--------------|--------------|--------------|
| **Conducting hub function to nearby stations** | **The distance between New Tokyo Station and Nihonbashi Station is slightly closer (600 m).** (Reference: 300m between Nihonbashi and Kayabacho on Tozai Line, 550m between Tokyo and Otemachi on Subway. Marunouchi Line, 600m between Nihonbashi and Mitsukoshimae on Subway Ginza Line, 350m between Sinjuku and Sincuku Sanchome on Subway Ginza Line) | **Since the distance from New Tokyo Station to Ginza Line Nihonbashimae Station is 630m, and the distance to Kyobashi Station 320m, travelling on foot is possible. This route offers a convenient transfer to Ginza Line including Mitsukoshimae Station** |
| **Potency for integral redevelopment of the district** | **Considering that the Sokobori-dori and the Nihonbashi River area are in an already advanced stage of development, this route plan is not able to catch up with them** | **Since the Chuo-dori has a potential for future redevelopment, this route is planned to pass at shallow depths, and is able to be constructed pursuing consistent relationship with New Tokyo Station** |
| **Potentiality for the district’s future goals** | **By establishing New Tokyo Station on Yasukunidaori and Yanagi-dori, this plan makes it possible to widely spread positive effects from improved Tokyo GCS function and revitalized district to the Chuo-dori area** | **With the development of underground passageways on Chuo-dori and Yasu-dori, this route will contribute to redevelopment and revitalization of roadside areas** |
| **Development for community town building** | **This plan may induce the development of Yasukunidaori and Yanagi-dori areas, contributing to the development of districts between Chuo-dori and Sotobori-dori** | **Pedestrian passageways provided under Chuo-dori and Yasu-dori, together with walking sidewalks, will make pedestrian flows smooth between New Tokyo Station and Tokyo Station, Nihonbashimae Station, and Kyobashi Station. This arrangement is expected to contribute to development of the surrounding areas** |
| **Contribution to district revitalization** | **Although this plan has the worst in accessibility, and has many development issues, there will be some ripple effects on town development and revitalization in this district** | **This plan may greatly contribute to revitalization and development of town in this district. Even though inferior to Route Plan A in some points of accessibility, they can however be solved by installing moving sidewalks** |

References:

[1] Ministry of Land, Infrastructure, Transport and Tourism: Future urban railways in the Tokyo Metropolitan Area, pp.29-30, 2016.4

[2] Japan Society of Civil Engineers: Underground Space Symposium Papers, Report Volume 23, pp51-pp58, 2018.1