Japan

Name: Japan Tunnelling Association
Type of Structure: Non profit organization
Number of Members: Total number 1481, number of corporate members 205

ASSOCIATION ACTIVITIES DURING 2018 AND TO DATE

WGs: JTA consists of the following four committees and each committee has WGs and task forces. Technology/International Communication /Events/Public Relations In each committee, the main activities are:

- Investigation, research and information exchanges on general techniques and on subjects of specific projects.
- Meetings such as lectures, symposiums, workshops, training and site visits : "Two-days seminars", "Site Visits" and "Lectures on topics of the year" (organize by Events committee)
- Publication of reports and documents Monthly journal "Tunnels and Underground"
- International cooperation

CURRENT TUNNELLING ACTIVITIES

Large-scale improvement project for MINAMISUNAMACHI-St and KIBA-St in TOZAI line (Tokyo metro)

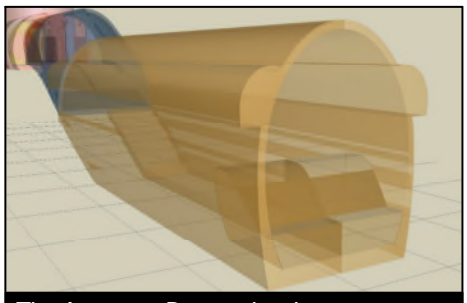
TOZAI line, which is 30.8km in the length, started operation in 1969. The average number of passengers per day is about 1.43million and congestion rate is almost 200% during rush hour. This is one of the most congested lines on the Tokyo metro and train delays are becoming chronic especially during morning rush hour. Non-structural measures such as time schedule revision and large-scale improvement project are currently under way.

MINAMISUNAMACHI-St. project is one example of a large-scale improvement project. This station is composed of

1 layer 2 spans, with an island platform serving 2 tracks. This station will be renewed to 2 layer 4 spans, and to 2 platforms serving 3 tracks to improve safety and convenience. The station was constructed under a canal with the caisson method in the 1960s but the surface was land-filled so now it is located under a road and private land. Due to the extremely soft and cohesive ground, groundwater lowering was not used to minimize the negative impact on the surroundings environment. As a countermeasure, ground improvement and a very rigid, reinforced concrete diaphragm wall using the most suitable construction sequence was carried out.

The Amagase Dam redevelopment project

The Amagase Dam located downstream of Lake Biwa, the largest lake in Japan, is a Concrete Arch Dam, and a multipurpose one for flood control, water supply and hydroelectric power generation. The redevelopment of Amagase Dam is to construct a discharge tunnel on the left bank of the Dam to strengthen it. This discharge tunnel is a waterway tunnel composed of a section for inflow, guide, gate chamber, stilling basin and a discharge. The discharge section is an extremely large cross-section tailrace tunnel (maximum excavation cross section 650m^2, height 26m, width 23m.



The Amagase Dam redevelopment project - Enlarged stilling Basin Section

This part crosses the fracture zone (around 10m in width) at the accretionary prism of the Paleozoic to Mesozoic era. The tunnel passes through a low soil covering position of about 40m in depth. This section is excavated by the NATM, drill & blast, bench cut method with pilot side and central drifts.

FUTURE TUNNELLING ACTIVITIES

The Tokyo Ring Road (Kan-etsu Expressway – Tomei Expressway Section)

The Tokyo Ring Road (Gaikan) is approximately 85km long and connects areas within an approximate 15km radius of the center of Tokyo. By dispersing the inflow of traffic that passes through the center of Tokyo, the Tokyo Ring Road will eliminate the chronic traffic congestion in the Greater Tokyo Area. Through a smoother flow of traffic, the traveling speed of vehicles on the road will increase and a large reduction in emissions is expected, creating a more comfortable and convenient city. Ring Road No.8 which is parallel to the planned Tokyo Ring Road has traffic congestion of about 18 times higher than the national average. Approximately 10% of vehicles flow into the surrounding residential roads, and traffic accidents are 5 to 11 times higher than those of municipal roads in the city. By constructing the Kan-etsu Expressway – Tomei Expressway Section, it will not only the alleviate congestion, improve the environment, enhance international competitiveness, and revitalize communities, but also allow Tokyo to continue to function as the capital in the event of a major disaster by facilitating smooth support and recovery operations. For the 16km section that runs between the Kan-etsu Expressway and Tomei Expressway, a 15.8m diameter deep-bore

The Amagase Dam redevelopment project - Plane view

tunnel structure (up to 40m) has been adopted. Currently 4 TBMs with diameters of 16m (the largest in Japan) are currently in full excavation. At the merging point of the ramp and main lane, a non-open cut tunnelling method is adopted to enlarge the tunnel underground. Under high pressure deep in the ground, construction will be carried out to extend 200 to 400m in one place. In the future after ground freezing has been carried out, 2 TBMs will dock underground near Inokashira Street.

Hokkaido Shinkansen (between Shin-Hakodate-Hokuto and Sapporo terminal)

The Hokkaido Shinkansen is a high-speed rail services starting from Aomori city, passing through Hakodate city to Sapporo city. The section between Aomori to Hakodate is already in operation while the extension to Sapporo is currently under construction. The extension consists mainly of tunnel sections which comprise 168.7km (~80%) out of the total 212km length. Upon completion, one of the tunnel section (Oshima tunnel, 32.7km) will be the longest mountain tunnel (NATM tunnel) on land in Japan and other sections will pass through Sapporo city (Sasson tunnel) with length of 26.2km. In general, most of the excavation method is by mountain tunnelling (NATM). Some sections such as the Youtei tunnel will be constructed by SENS* method while the Sasson tunnel will be excavated by Shield (EPBM/Slurry) Method.

**SENS (Shield ECL NATM System: Excavation is conducted by maintaining the stability of the face with the shield tunnelling method, while aiming for early closure with primary support that applies the extruded concrete lining (ECL) method. The tunnel is completed by casting concrete for the secondary lining after the displacement convergence of the ground, as in the case of spraying concrete with NATM)*

STATISTICS

1. Length or volume excavated

35 % mechanized
55% conventional during 2018

2. Amount (USD or EUR) of tunnelling/ underground space facilities awarded in 2018 - US$3.5 bn

3. List of tunnels under construction

	No. of construction section	Total length (km)	Contract amount (US$bn)
Road	252	362	19
Railway	66	179	5
Waterway	129	208	4
Overseas	24	88	5
Others	46	77	2
Grand total	**517**	**914**	**35**

EDUCATION ON TUNNELLING IN THE COUNTRY

The following four universities' example below

Kanazawa Institute of Technology

Classes on "Tunnel and tunneling technology" are implemented as follows:
Tours of tunnel construction sites such as Shinkansen (high-speed rail) and the exchange of views at the site. Lectures on planning, designing, construction and maintenance of tunnel projects on expressways. Lectures on planning, designing, construction and maintenance of tunnel projects on railroads. Lectures on diagnostic technology of old tunnels. Study of the repair techniques of the tunnels deteriorated over a long period of time.

Kyoto University

In the undergraduate program, the mechanism of tunnel excavation, the construction methods of mountain tunnels (NATM) and urban tunnels (TBM) are introduced in the class for Rock Mechanics and Geotechnical Engineering. In the post graduate program, the advanced mechanism of tunnel excavation and the auxiliary methods of tunnel excavation are introduced in the class for Construction Engineering. These classes include the field visit of actual tunnel construction sites. In addition, in the class for River Engineering or others, the public uses of underground space, such as underground discharge channel, urban redevelopment, carbon capture and sequestration, nuclear waste disposal issue, are introduced.

Nagaoka University of Technology, Civil & Environmental Engineering Department

As for the subject concerned with tunnelling, the following classes are offered.

1. Special lecture (laboratory basis), 3rd year, undergraduate school.
In this class, tunneling methods are introduced briefly and the overview of mechanized tunnelling method are provided.

2. Geological engineering, 4th year, undergraduate school.
This class provides the basic aspects of rock engineering and geological engineering, which are used to construct large scale civil engineering structures and tunnels. This class also introduces the case records of conventional tunnelling method.

3. Special seminar (laboratory basis), graduate school.
In this class, the selected recent topic on tunnelling is introduced briefly, and the feature of the topic is discussed among the students in the laboratory.

Tokyo Metropolitan University

Delivers two lectures regarding tunneling, both for undergraduate and graduate students. The former lecture aims to help understand the fundamental concept and the latter one gives both theoretical and actual knowledge.

1) Fundamental Tunnel and Underground Space Technology (for undergraduate course)
Underground space and structures should be effectively used in Japan because of the narrow land space and low plane area. The actual state of underground space usage with domestic and foreign examples is firstly introduced and the relation between the stability of structure and characteristics of ground is delivered. Also the difficulty of grasping the physical characteristics by ground survey is shown and the design and construction of underground structure and its influence is explained. Fundamental knowledge of surveying, design, construction and maintenance of tunnels and underground structures is introduced.

2) Advanced Tunnel and Underground Space Technology (for graduate course)
The behavior of underground structures such as tunnels, underground cavities and space is not only influenced by its surrounding rock and ground, but also by both movements interacting at the same time. The geological condition in Japan is extremely complex and the design and construction of underground structure needs to be done using insufficient data because the accuracy of surveys for construction is limited. The detail of various kinds of actual tunnel and underground construction, with consideration for the condition of underground, is delivered, in addition to the theory of mechanical characteristics and the concept of load evaluation. Also, the concept of underground structure design is explained, on the basis of complexity of geology, limitation of survey and the characteristics of construction. Advanced maintenance methods of underground structure, the effect of various facilities considering the human characteristics inside tunnel and the damage of tunnel against earthquake in Japan are also introduced.