

Tunnel Activity 2020 Overview

1. Preface

The number of yearly tunnel construction projects, such as the Shinkansen, expressways, and water supply and sewerage, remain high in Japan. These constructions are done while resolving technical issues such as complicated geological and soil conditions and proximity to existing constructions.

While such progress is made, many tunnels in Japan were built during the period when Japan's economy was boosting. Tunnels surviving their 50th year are increasing. Need for maintaining and managing such tunnels is becoming larger, in a shrinking economy with a smaller pool of engineers. Japan's tunnels are being built and maintained under such severe conditions.

This publication introduces latest projects and new technology to overcome technical issues.

2. Tough Geological Conditions in Japan

In a global view, Japan is one of the smaller island countries with a total of 380,000km² national land, of which more than 70% is mountainous. Almost 130 million people live in Japan, where habitable land is extremely scarce. Major cities, such as Tokyo and Osaka, are overcrowded, and most of the space



Photo-2.1 A Tunnel Face Sample in Japan with Soft and Hard Ground

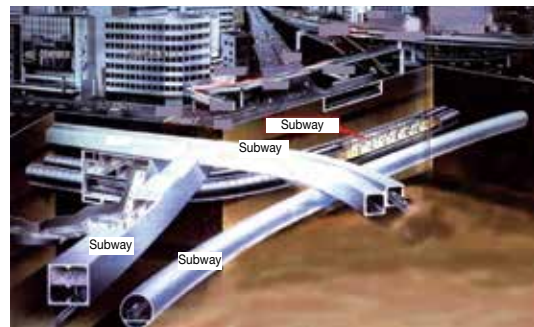


Fig.-2.2 Advanced Usage of Underground Space in a Large City (Around Iidabashi station, Tokyo)

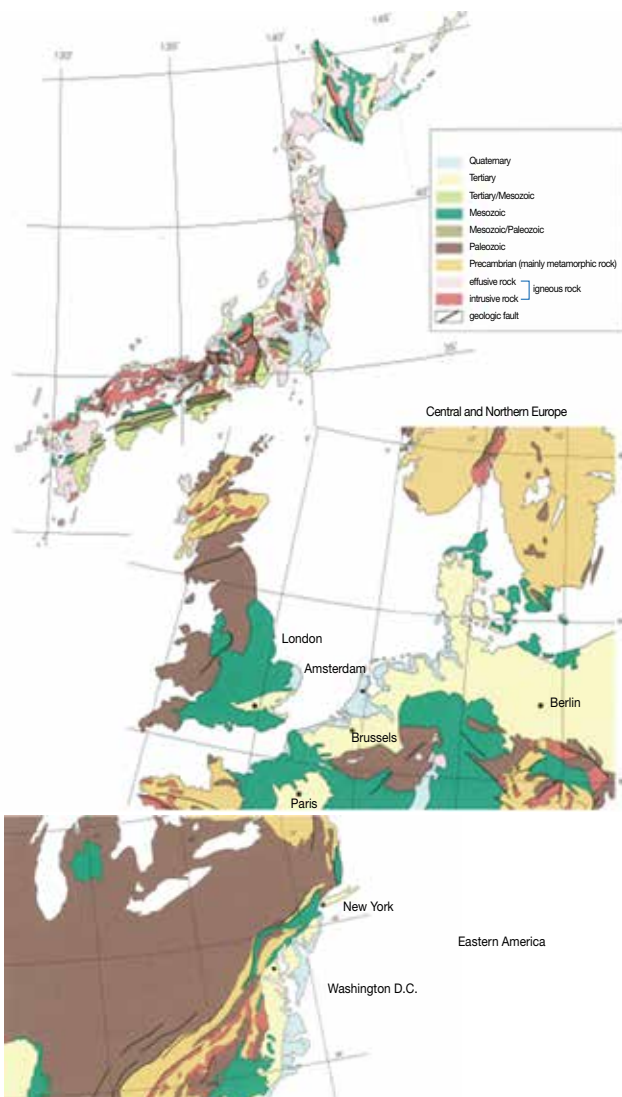


Fig.-2.1 Differences of Geology of Japan and the Western world

above the ground is used. Many social infrastructures are built under ground. As major cities are scattered around the country, travelers must reach them by going through steep mountains and straits, making the need of tunnels naturally high.

However, Japan is one of the countries most ill-fitted for tunnel construction. The Japanese Archipelago sits at the point where the Pacific and Philippine Plates meet, making the geological structure of its land significantly complicated compared to Europe or America (Fig.-2.1). In Japan, it is common to see a different geology every 1m of excavation, with hard and soft rock mix showing in one tunnel face (Photo-2.1). The plains surrounding major cities are created by deposits of newer geological eras, more often being soft ground. The underground space of such areas is already highly used for social infrastructure such as underground railways, water supply, and sewage. When newly constructing underground, the project would require building structures narrowly adjacent to existing constructions within the soft ground (Fig.-2.2).

To make a long story short, Japan has very severe natural ground conditions among the world, with high needs of underground usage. So, development of greatly advanced underground construction technology has been and will be critical for successful tunnel projects in Japan.

3. Current Tunnel Situation in Japan

There are many underground infrastructures built in Japan, and steady investment is made to maintain and grow the domestic economy, as well as creating safe and secure land (Fig.-3.1). After peaking in 1995, investment in infrastructure dropped slowly year by year, since the government restrained public investment. Recent years see increase of in

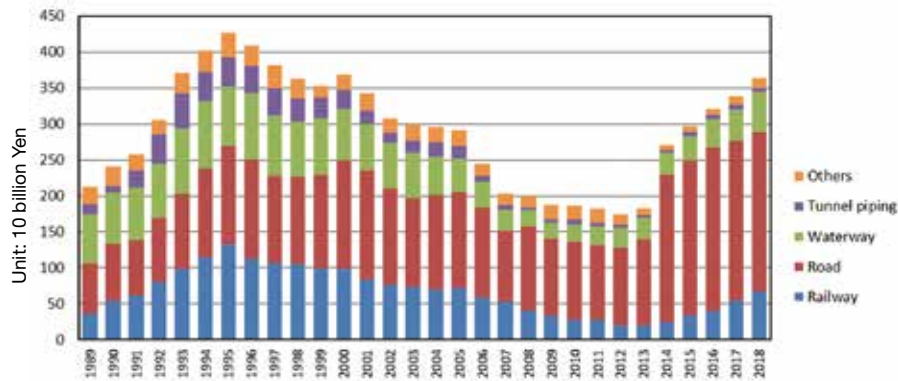


Fig.-3.1 Trend of construction investment in tunnels and underground space

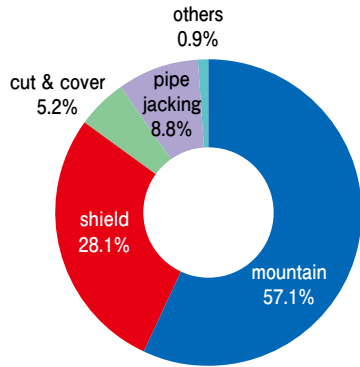
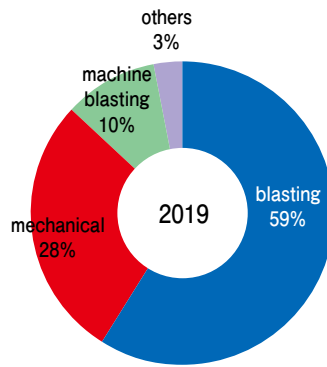
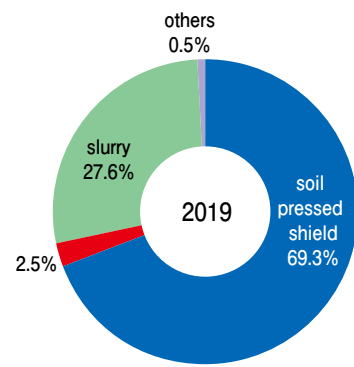


Fig.-3.2 Ratio by Tunnel Construction Method



Conventional Method



Shield tunnelling Method

Fig.-3.3 Ratio of Tunnel Construction by Method

investment due to reconstruction efforts starting in 2014 after the Great East Earthquake and the construction for 2020 Tokyo Olympic and Paralympic Games.

Fig.-3.2 and 3.3 shows the trend of construction investment in tunnels and underground space by type. Mountain tunnels are 57%, with 60% of that using blasting. Shield tunnels consist of 28% of all constructions, and 70% of that use soil pressed shield method.

4. Current Situation of Tunnel Maintenance and Management

Japanese tunnels were most constructed during the period of high economic growth, with many tunnels lasting for more than 50 years. Tunnel maintenance and management is becoming a large issue. Current situation of road tunnels and railway tunnels are as follows:

As of 2017, there are approximately 11,000 locations with a total of 4,500km of tunnels built in the road system (Fig.-4.1). The percentage of tunnels over 50 years is around 21%, which will increase to around 35% in the next ten years. The revision of the Road Traffic Act in 2014 requires all road tunnels' total lining surface to be visually checked onsite at

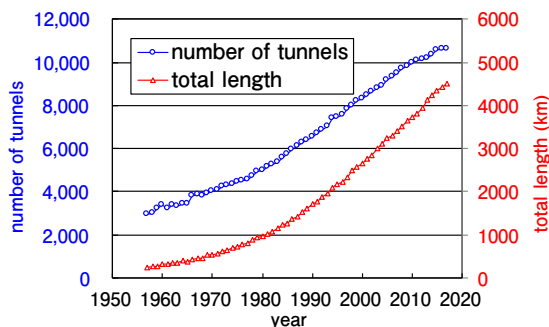


Fig.-4.1 Number and Length of Road Tunnels in Japan

least once in five years.

(2) Railway Tunnels

As of 2015, the total length of railways owned by the seven JR group companies (former national railway) has become 20,117km. There are 3,627 tunnels, consisting 2,462km of that distance (*). The ratio of tunnels more than 50 years old is almost 60%.

There are directions by the Ministry of Land, Infrastructure, Transport and Tourism (MILT) determining the technical standards of railways, and these directions state the frequency of inspections. Regular inspections (Standard General Inspection) must be held within two years. In-depth inspection (Special General Inspection) must be held within 10 years for Shinkansen, and within 20 years for other railway tunnels in addition to regular inspections.

* Annual Railway Statistics Report (2015), MILT

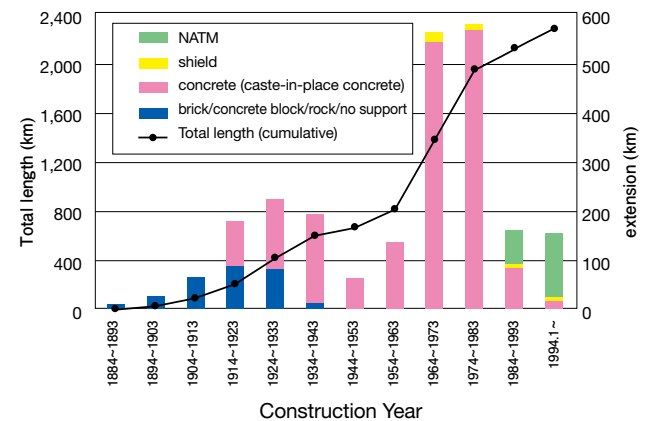


Fig.-4.2 Number of tunnels constructed by the seven JR companies (former national railway) by year (as of 2002)
Source: "Tunnel Library 14 Tunnel Maintenance in Japan", Japan Society of Civil Engineers, July 2005