

現在整備を行っている北海道新幹線(新函館北斗・札幌間)の約80%を占めるトンネルにおける坑口部および坑門の設計, 施工について報告するものである。当該区間は厳しい積雪寒冷地という北海道特有の条件下にあり, 凍害対策や雪崩対策の検討を行っている。凍害対策については, 断熱工の厚さや施工距離を検討のうえで, 断熱工を実施している。雪崩対策については, 雪崩危険度を評価したうえで対策を検討している。また, 耐震性などの従来の問題点を解決できる坑門の形式として標準的にGRS坑門(坑門背面を補強盛土構造とし, ジオテキスタイルにより坑門と一体化させた構造)を採用していること, 突出型の坑門を採用していることなどについて, 検討事例・施工事例を交えて紹介する。

Design and Construction of Portal Zones for the Hokkaido Shinkansen

By Takeshi Ejima, Japan Railway, Construction, Transport and Technology Agency

The authors report on the design and construction of portal zones and portals for the tunnels on the Hokkaido Shinkansen (between Shin-Hakodate-Hokuto and Sapporo), which accounts for approximately 80 % of the line. Since this line is situated in a severe snowy and cold region, a condition unique to Hokkaido, measures to prevent frost damage and avalanches are currently under consideration. To prevent frost damage, frost insulation is carried out after considering the thickness and installation distance of the frost insulation. Measures against avalanches are considered after evaluating the avalanche hazard level. We also introduce the adoption of GRS tunnel portals (the back of the tunnel portal is a reinforced soil integrated with the tunnel portal using geosynthetics) as a standard tunnel portal type that can solve traditional problems such as seismic resistance, and the use of protruding tunnel portals, along with examples of studies and constructions.

南アルプストンネルは, 中央新幹線事業のうち山梨, 静岡, 長野を貫く全長約25kmの長大山岳トンネルであり, このうち, 長野工区は長野側約8.4kmの区間である。前方調査ボーリング(高速長尺先進ボーリング:FSC-100)による地質調査の際に, 戸台構造線において当初想定しなかった脆弱な蛇紋岩区間が存在することが判明し, その範囲や詳細な地質状況を特定するため, シールドリバースボーリングによる地質調査を行った。この地質調査結果にもとづき, 先進坑掘削に対して円形の支保パターンを選定し, 一部の区間では, 二重支保工を施工することで, 脆弱区間を突破した。次に, 先進坑掘削実績にもとづいて, 本坑の支保パターンを選定し, こちらも一部の区間で, 二重支保工を施工することで, 脆弱区間を突破した。本稿はその施工実績について報告するものである。

Breaking through Weak Serpentine Sections Using Prediction Ahead of Tunnel Face with Advanced Boring

—The Chuo Shinkansen, the Minami-Alps Tunnel, the Nagano Lot—

By Yuya Sato, Central Japan Railway Company

The Minami-Alps Tunnel is a 25-km-long mountain tunnel that runs through Yamanashi, Shizuoka, and Nagano as part of the Chuo Shinkansen project. The Nagano Lot on the Nagano side is approximately 8.4 km in length. During the geological survey using prediction ahead of the tunnel face using advanced boring (high-speed long-length advanced boring: FSC-100), weak serpentine sections were discovered in the Todai Tectonic Line that had not been initially anticipated. To identify its extent and detailed geological conditions, a geological survey was conducted using shield-reverse boring. Based on the results of this survey, a circular support pattern was selected for the excavation of the pilot tunnel, and in some sections, double steel support was installed to excavate through the weak sections. Next, based on the excavation results of the pilot tunnel, a support pattern for the main tunnel was selected, and in some sections, double steel support was installed to excavate through the weak sections. In this paper, the authors report on the construction results.

高速道路リニューアルプロジェクトの一環として、供用後のトンネル地山膨張による路面隆起や円形水路などの周辺設備損傷に対するトンネル補強工事を実施している。塑性圧の増加に対し、インバート設置により閉合構造とすることで安定性を保つことが目的である。過去のインバート設置工事は、対面通行による施工が行われてきたが、高岩山トンネルで同様の規制を行うと、週末には最大30km超の渋滞が予想され、交通への影響が大きかった。本工事は、半断面施工により片側車線を供用しつつ施工する方式を採用した。さらに、工期短縮による交通影響の低減を目的として、プレキャストブロックを用いたインバート構築の開発に取り組んだ。狭隘な空間内でも効率的に施工可能な使用機械やプレキャストブロックの仕様を検討し、供用中道路トンネルでの試験施工結果を報告する。

Installation of Cast-in-Place and Precast Inverts for Weekend 4-Lane Road Opening —The Joshin-Etsu Expressway, the Takaiwayama Tunnel—

By Daiki Kamasaka, East Nippon Expressway Company Limited

As part of an expressway renewal project, tunnel reinforcement work is being conducted to prevent road surface heaving and damage to circular drainage and other peripheral facilities due to the squeezing of the ground around the tunnel after the start of operation. The goal of this work is to maintain stability against increased plastic pressure by installing inverts to create a closed structure. In the past, traffic was usually restricted to temporary 2-way operation during invert installation. However, if similar restrictions were applied to the Takaiwayama Tunnel, traffic jams of up to 30 km or more could be expected on weekends, which would have a significant impact on traffic. In this project, the authors adopted a half-section construction method, allowing one lane to remain in service. In addition, an invert installation method using precast blocks was developed to reduce the impact on traffic by shortening the construction period. In this paper, we describe the specifications of the machinery and precast blocks that can be used efficiently even in narrow spaces and report the results of test construction in a road tunnel currently in use.

蛇紋岩を掘削対象とするトンネルの設計においては、定量的因子では適応できない事象も多いことから、経験的な指標として類似地山を参考とすることや、工学的モデル評価として数値解析により掘削工法や支保構造を決定することが多い。しかしながら、経験的手法では客観的な根拠に乏しく、また、工学的モデル評価では地質調査などの限界から入力物性値の妥当性や検証が難しい。そこで、近年、蛇紋岩を掘削対象としたトンネル工事における事象をもとに、蛇紋岩トンネル設計に向けた新たな地山評価へ向けて考察を行った結果、先進ボーリングマシンへの給圧や掘進長、ボーリングコアの蛇紋岩形態別の介在率および内空変位量から、ある一定の傾向を示すことがわかった。これらから適切な支保構造の選定といった定量的な地山評価への適用を図り、施工管理への活用を提案する。

Proposal for the Use of Advanced Boring in Tunneling through Serpentine By Hirokazu Sasaki, Hokkaido University

When designing tunnels excavated through serpentine, many phenomena cannot be analyzed using quantitative factors, so it is common to determine excavation methods and support structures by referring to tunnels in similar ground as empirical indicators or using numerical analysis as an evaluation of engineering models. However, empirical methods lack objective evidence, and evaluations of engineering models are difficult to validate and verify the input property values due to the limitations of geological surveys and other factors. Based on recent events that have occurred during the excavation of tunnels in serpentine, the study toward a new ground evaluation for the design of tunnels in serpentine shows certain trends based on the feeding pressure to the advanced boring machine, excavation length, the inclusion rate of each serpentinite type in the borehole core, and internal displacement as the result. The authors aim to apply these findings to quantitative ground evaluation, such as the selection of appropriate support structures, and propose their use in construction management.