施工 07

中央構造線に近接した大土かぶりトンネルの施工
―三遠南信自動車道　青崩峠トンネル静岡側工区―

国土交通省　小池　良宏

青崩峠トンネル(仮称)は，長野県と静岡県の県境に位置する全長4,998mの山岳トンネルである．本トンネルは中央構造線に対して離隔距離約500mで平行に位置するため，断層運動の影響を受けた複雑な地質が切羽に出現する．この複雑な地質に加え，最大土かぶりが600mと大きいため高土圧条件下での施工となった．青崩峠トンネル(仮称)のうち静岡側工区(L=2,144m)では，土かぶりが300mを超えるころから，変位が増大し，変状が発生した．変位抑制対策として増しロックボルト，二重支保工，および土かぶりが580mを超える地山深部では54N/mm^{2}の超高強度吹付けコンクリートを適用することにより，無事貫通するに至った．本稿では，大土かぶりかつ中央構造線近傍の脆弱な変成岩類が出現する地山における山岳トンネルの施工について報告する．

Construction of a Tunnel with a Large Earth Cover Close to the Median Tectonic Line
―The San-en Nanshin Expressway, the Aokuzure-toge Tunnel, the Shizuoka Side Lot―

By Yoshihiro Koike, Ministry of Land, Infrastructure, Transport and Tourism

The Aokuzure-toge Tunnel (tentative name) is a 4,998 m-long mountain tunnel located on the border between Nagano Prefecture and Shizuoka Prefecture. Since the tunnel passes parallel to the Median Tectonic Line at a distance of approximately 500 m, complex geology affected by fault movement appears in a face. In addition to this complex geology, the tunneling was carried out under high earth pressure conditions due to the large maximum earth cover of 600 m. In the Shizuoka side lot of the tunnel (L = 2,144 m), displacement increased and deformation occurred when the earth cover exceeded 300 m. Applying additional rock bolts, double steel support and using ultra-high-strength shotcrete with a strength of 54 N/mm^2 in deep areas where the earth cover exceeded 580 m as displacement control measures allowed to excavate the tunnel successfully. In this paper, the authors report on the construction of the mountain tunnel with a large earth cover in the ground with fragile metamorphic rocks in the vicinity of the Median Tectonic Line.

施工 19

密集した民家の環境保全と供用線の安全に努めたⅡ期線施工
―佐世保道路　天神山トンネル―

西日本高速道路(株)　中原　光一

佐世保道路天神山トンネルは，延長909mの山岳トンネルであり，3万台/日以上が通過する暫定2車線に近接したⅡ期線施工を行った．周辺に民家が密集した市街地，高低差のある狭小ヤードなどの厳しい条件下で，安全性や騒音・振動などの環境保全に十分配慮する必要があった．西側坑口には地すべり地に加え，供用トンネルには盤ぶくれ変状があり，計画時からトンネル掘削による影響が懸念され，慎重な施工が求められていた．本稿では，制約条件下でのずり処理などの仮設備検討および地すべりと盤ぶくれへの影響検討と施工結果について報告する．

Protecting the Environment of Densely Populated Housing Area and Ensuring the Safety of Existing Road during Phase II Line Construction.
―The Sasebo Road, the Tenjin-Yama Tunnel ―

By Koichi Nakahara, West Nippon Expressway Company Limited

The Tenjin-yama Tunnel on the Sasebo Road is a 909 m-long mountain tunnel. Phase II construction of the tunnel was carried out close to a temporary two-lane road through which more than 30,000 vehicles pass every day. Severe conditions, such as urban areas with dense private dwellings in the vicinity and narrow yards with height differences required giving sufficient consideration to safety and environmental protection factors, such as noise and vibration. In addition to the landslides at the west portal, deformations of heaving were detected in the existing tunnel, and there were concerns from the planning stage about the impact of tunnel excavation, so careful works were required. In this paper, the authors report on the investigation of temporary facilities such as mucking works under constrained conditions, the investigation of the effect of the construction on landslides and heaving, and the construction results.

施工 49

諏訪盆地北縁の断層群により破砕作用を受けた不良地山のトンネル掘削
―国道20号下諏訪岡谷バイパス　山田トンネル―

国土交通省　髙桑　信一

当該地域は，糸魚川-静岡構造線と中央構造線が交差する諏訪湖北側の諏訪盆地北縁山地に位置し，断層群と熱水変質の影響で破砕作用を受け粘土化された不良地が多くみられる．過去に近傍で施工されたトンネル工事において，大量湧水や地表陥没などが発生した記録が残っていることからも，難工事になることが予想されたため，剛性の高い支保構造と天端や切羽面の補強が必要であった．トンネル後半は地下水位が高く，断層破砕帯も想定されていたため，緩んだ地山の崩落や大量出水の発生が危惧されたことから水抜きボーリングにより前方地下水位の低下を確認しながらの掘削を行った．短いトンネル延長ではあるが，過去に発生した大量湧水や地表陥没事象の教訓を活かし，同一事象を再発させないことを念頭に本現場で実施した掘削補助工法について報告する．

Tunneling in Defective Ground Fractured by Faults on the Northern Edge of the Suwa Basin.
―The National Route 20, Simo-Suwa Bypass, the Yamada Tunnel―

By Shinichi Takakuwa, Ministry of Land, Infrastructure, Transport and Tourism

The tunneling site is located in the mountains on the northern edge of the Suwa Basin, north of Lake Suwa at the intersection of the Itoigawa-Shizuoka Tectonic Line and the Median Tectonic Line. Defective grounds that have been fractured and turned into clay due to the effects of faults and hydrothermal alteration are common. It was predicted that the construction would be difficult as there are records of large water inflows and ground surface subsidence occurring during the construction of nearby tunnels in the past, so a rigid support structure and reinforcement of the crown and face were required. The groundwater level was high in the latter half of the tunnel and the existence of fault fracture zones was assumed, and there were concerns that the loose ground would collapse and a large amount of water would come out, so the tunnel was excavated while confirming the groundwater level in front of the tunnel using drainage boring. In this paper, the authors describe the auxiliary methods implemented at this site despite the short length of the tunnel to prevent the recurrence of the same events, taking advantage of the lessons learned from past large water inflows and ground surface subsidence events.

施工 59

ALPS処理水を海洋放出する海底シールドトンネルの設計・施工
―東京電力　福島第一原子力発電所放水トンネル―

東京電力ホールディングス(株)　林　　達也

東京電力福島第一原子力発電所の多核種除去設備など処理水希釈放出設備の設置工事は，2022年８月より本格着工し，2023年６月に工事が完了している．その後，政府から多核種除去設備など処理水の海洋放出の開始時期にかかわる判断が示され，原子力規制委員会により認可された実施計画にもとづき，2023年８月に同設備でALPS処理水の海洋放出を開始している．この一連の工事のうち放水設備では，発電所から海底に設置した放水口までの約１kmの海底トンネル(内径2.59m)を泥水式シールド工法で施工した．トンネル工事は水圧0.2MPaの海底下でN値50以上の岩盤層を掘進し，海底のケーソンに到達，無事にALPS処理水の海洋放出の工程を確保した．本稿では，このトンネル工事の設計と施工実績について報告する．

Design and Construction of an Undersea Shield Tunnel to Discharge ALPS Treated Water into the Sea
―TEPCO Fukushima Daiichi Nuclear Power Plant Discharge Tunnel―

By Tatsuya Hayashi, TEPCO Holdings, Incorporated

Full-scale construction work to install dilution and discharge facilities for treated water, including multi-nuclide removal equipment, at TEPCO's Fukushima Daiichi Nuclear Power Station began in August 2022 and was completed in June 2023. Subsequently, the government made a decision regarding the timing of the start releasing water treated by the multi-nuclide removal equipment into the sea, and based on the implementation plan approved by the Nuclear Regulatory Authority, discharge of the ALPS treated water at this facility began in August 2023. As a part of this construction work for the discharge facility, an approximately 1 km long undersea tunnel (inner diameter 2.59 m) was constructed using the slurry shield method from the power station to the outlet installed on the seabed. The tunnel construction was carried out under the seabed with a water pressure of 0.2 MPa through a bedrock layer with an N value of over 50, reaching the caisson on the seabed and ensuring a safe process of discharging ALPS treated water into the sea. In this paper, the authors report on the design and construction results of this tunnel.

計画
71

札幌都心周辺における大口径下水道幹線の2系統同時移設計画
―創成川処理区下水道新設工事（シールド工区）―

札幌市　藤田　将輝

札幌市下水道河川局は，2023（令和5）年度より，国道5号創成川通への地下トンネル新設に先行して，2026（令和8）年度末までの完了を目標とした大口径下水道幹線2系統，計12kmの移設工事に取り組んでいる．工事区間は札幌都心周辺に位置し，全8工区が同時並行的に進行する．このうち，延長の大部分を占めるのがシールド工法による3工区（外径2,600～3,900mm）であり，各工区の工事発注にあたっては，3kmを超える長距離掘進，最小曲線半径R=15 mの急曲線や軟弱地盤における連続急曲線（R=25 m× 4か所），1.0Dを下回る小土かぶり，そしてさまざまな支障物への対応といった課題があった．本稿では主に設計段階における工事計画の検討内容について報告する．

Plan for Simultaneous Relocation of Two Large Diameter Main Sewers in the Vicinity of Sapporo City Center
―Construction of a New Sewer in the Soseigawa Treatment Area (Shield Lot)―

By Masaki Fujita, Sapporo City

The Sapporo Sewerage and River Bureau has been working since FY 2023 to relocate a total of 12 km of the two large-diameter main sewers, aiming to complete the work by the end of FY 2026, previous to the construction of a new underground road installed on the Soseigawa-dori, National Route 5. The construction site is located in the vicinity of Sapporo city center, construction will proceed simultaneously in all eight lots. The shield tunneling method was used for three lots (outside diameter 2,600 to 3,900 mm), which accounted for the majority of the construction length. The project had to deal with a variety of obstacles and challenges in each section: long-distance tunneling of over 3 km, steep curves with a minimum curve radius of R = 15 m, continuous steep curves in soft ground (R = 25 m × 4 locations) and small earth cover of less than 1.0 D. In this paper, the authors focus on the construction planning studies carried out at the design stage.