

北海道新幹線(新函館北斗・札幌間)のうち札幌トンネルは、全長約26.2kmのトンネルであり、6つの工区に分割して工事を進めている。そのうちの1つの工区である札幌工区は、札幌市街地直下を通過する。工区中間に位置する発進立坑より、小樽方に約1.5km、札幌方に約6.9km掘進する整備新幹線初のシールドトンネル工事である。2022年1月下旬より小樽方の初期掘進に着手し、後続台車や垂直ベルコンの組立などによる2度の段取り替えののち、2022年9月上旬より本掘進を開始した。おおむね計画どおり掘削できたが、地上への気泡材漏出、巨礫によるスクリーコンベヤの閉塞などの事象も発生した。2023年4月14日に岩盤の出現によりカッタートルクが上限を超えたため約1.4kmで小樽方の掘進を完了した。本稿では、小樽方における掘進管理について発生事象を含めて報告する。

Shield Tunnel Excavation Management and Emergency Response

—The Hokkaido Shinkansen, the Sasson Tunnel Sapporo Lot—

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The Sasson Tunnel on the Hokkaido Shinkansen (between Shin-Hakodate-Hokuto and Sapporo) is a 26.2 km long tunnel divided into six construction lots. One of the construction lots, the Sapporo Lot, passes directly under the urban area of Sapporo. This is the first shield tunnel constructed for the Shinkansen, which will be excavated about 1.5 km toward Otaru and 6.9 km toward Sapporo from the starting shaft located in the middle of the construction Lot. The initial boring on the Otaru side began in late January 2022, and the main excavation began in early September 2022 after two changeovers for the assembly of the backup cars and vertical belt conveyor. Although the excavation was generally completed as planned, there were some incidents such as leakage of foam to the ground surface and blockage of the screw conveyor by boulders. On April 14, 2023, the cutter torque exceeded the upper limit due to the appearance of rock, and the excavation on the Otaru side was finished after approximately 1.4 km. In this paper, the authors describe the excavation management on the Otaru side, including the incidents that occurred during the excavation.

中央新幹線第一南巨摩トンネルは、全長716mの約30%にあたる約210mの区間において小土かぶりや崖錐堆積物および断層破碎帯と直交している。そのうち、崖錐堆積物区間については、泥濘化による天端および鏡面の不安定化が懸念されたため、注入式フォアポーリングによる天端沈下抑制と核残しによる鏡面の安定性確保、断層破碎帯区間については、地山強度比が小さく同様に天端および鏡面の不安定化が懸念されたほか、大量湧水の発生やスメクタイト含有による膨圧が懸念されたため、坑内から実施した中尺水平ポーリングによる地下水位低下と特Sパターンの適用などにより、本トンネルは2023年10月に品川～名古屋間の本線トンネル(実験線区間除く)で初めて貫通することができた。本稿では、小土かぶりの崖錐堆積物、断層破碎帯区間を、各種補助工法を用いて掘削した実績を中心に報告する。

Breaking through Talus Deposits and Fault Fracture Zone Sections at Shallow Depth Using Various Auxiliary Methods

—The Chuo Shinkansen, the Dai-Ichi Minami-Koma Tunnel—

By Takumi Terashita, Japan Railway, Central Japan Railway Company

A 210 m long section of the Chuo Shinkansen Dai-Ichi Minami-Koma Tunnel which is about 30% of the total length of 716 m crosses a talus deposit and fault fracture zone orthogonally at shallow depth. In the talus deposit section, there was concern that the crown and cutting face would become unstable due to the ground becoming muddy, so injection forepoling was used to control the crown settlement and the ring cut method ensured the stability of the opposite surface. In the fault fracture zone, the competence factor was small and there was also concern that the crown and the cutting face would become unstable. There were concerns about large water inflow and swelling pressure due to smectite content. To address these concerns, medium-length horizontal boring to lower the groundwater level was performed and the Special-S pattern was applied. As a result, the tunnel was successfully penetrated in October 2023 for the first time in the mainline tunnel between Shinagawa and Nagoya (excluding the experimental section). In this paper, the authors focus on the results of the excavation of talus deposits and fault fracture zone sections at shallow depths using various auxiliary methods.

釜利谷庄戸トンネルは、圏央道の一部である横浜環状南線のうち、横浜横須賀道路の釜利谷JCTとの接続部に位置する延長約1kmのトンネルである。地質は新第三紀鮮新世～第四紀更新世の野島層凝灰質砂岩が主体であり、土かぶり7～14mとなっている。超大断面の双設トンネルとなっているJCT分合流区間の上り線は、最大5車線を包括する幅29.5m、断面積485m²の超大断面トンネルでNATM施工としては世界最大級の掘削断面積を有する道路トンネルであり、計測データの監視や安全対策を行いながら2023年3月に最大断面箇所の掘削を完了した。本稿では、上り線における超大断面施工のための先進導坑掘削による地質状況の事前確認、地表面沈下対策としての上半仮閉合や下半・インバート部の一括施工による早期閉合、近接する閑静な住宅街への工事影響を極力抑えるための施工機械の配置の工夫などについて報告する。

Challenging an Extremely Large Cross Section (485 m², One of the Largest in the World) with Urban NATM (1)

—The Yokohama Ring Expressway South Line (Ken-O Expressway), the Kamariya-Shodo Tunnel—

By Daisuke Matsumoto, East Nippon Expressway Company Limited

The Kamariya Shodo Tunnel is a 1 km long tunnel located on the Yokohama Ring Expressway South Line, part of the Ken-O Expressway, at the junction of the Yokohama-Yokosuka Road with Kamariya JCT. The geology is mainly composed of tuffaceous sandstone of the Nojima Formation of Neogene Pliocene to Quaternary Pleistocene age, and the depth is 7 to 14 m. The inbound lane of the JCT with divergence and confluence part, which is a twin tunnel with an extremely large cross-section has a width of 29.5 m and a cross-sectional area of 485 m². The tunnel includes up to five lanes and is one of the largest tunnels in the world excavated using NATM. The excavation of the largest cross-section was completed in March 2023 while monitoring measurement data and implementing safety measures. In this paper, the authors report prior confirmation of the geological conditions by boring a pilot tunnel for construction of an extremely large cross-section in the inbound lane, top heading temporary invert, and early closure by joined construction of the bottom and invert section to prevent settlement of the ground surface, and creative arrangement of construction machinery to minimize the impact of construction on the adjacent residential area.

渋谷駅周辺では、100年に一度と呼ばれる民間再開発が進められており、併せて歩行者ネットワークの構築や公共交通の乗り換え利便性向上を図る取り組みが進められている。本工事は、その取り組みの一環として、国道246号渋谷駅周辺の交通を確保しながら国道直下に地下歩道、地下車路を開削工法により構築する。本工事で構築する地下車路は近接構造物が多く、地下で躯体接続を行う大型再開発事業の竣工時期を考慮し、早期に躯体構築が必要であった。このため、部分プレキャスト部材(PPCa)を用いたボックスカルバートを採用し、工程短縮を図るとともに、施工計画の深度化、関係者間の意思疎通の効率化を目的にVRなどのDX技術を用いた施工計画の立案を実施した。本稿では、PPCaボックスカルバートの現場初適用および施工計画に用いたDX推進について報告する。

Shortening the Process and Promoting DX for Cut-and-Cover Tunnels through Partial Use of Precast Members

—The Project around Shibuya Station on National Route 246, the Shibuya Station West Exit Tunnel—

By Hideki Toyomura, Ministry of Land, Infrastructure, Transport and Tourism

The area around Shibuya Station is undergoing a once-in-a-century private sector redevelopment project, and efforts are underway to build a pedestrian network and improve the convenience of public transportation transfers. As part of this project, an underground walkway and an underground automobile road will be constructed directly under the national route using the cut-and-cover method while maintaining traffic flow around Shibuya Station on National Route 246. The underground automobile road to be constructed in this project had many structures close, and it was necessary to construct the structure as soon as possible in consideration of the completion date of the large-scale redevelopment project which would require the underground connection. For this reason, a box culvert using partially precast concrete members (PPCa) was adopted to shorten the construction process, and construction plans were developed using VR and other DX technologies to deepen the construction plan and improve the efficiency of communication among the involved parties. In this paper, the authors report on the first on-site application of a PPCa box culvert and promoting DX usage for construction planning.

火薬取締法施行規則の一部が改正(2021年10月公布, 2022年1月施行)され, トンネル坑内において装填設備を使用して含水爆薬を密に装填し, 逆起爆する場合は込物の使用は不要となった. 筆者らは爆薬装填設備として爆薬遠隔装填システムを標準化しており, 装填設備を使用した発破掘削が, 込物填塞の有無による「安全性」と「発破効率」にどの程度の影響を及ぼすかを把握することを目的とした実証実験を稼働現場で実施した. 本稿はその実証実験結果について報告するものである.

A Study on Improvement of Blasting Efficiency Using Remote Explosive Loading System

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The Ordinance for Enforcement of the Explosives Regulation Act was partially revised (promulgated in October 2021 and enforced in January 2022). According to the regulation, the use of stemming materials is no longer necessary when emulsion explosives are densely loaded using loading equipment, and detonated through indirect initiation inside a tunnel. The authors have standardized a remote explosive loading system as an explosive loading equipment and conducted a demonstration experiment at an operational site to understand the effect of blasting excavation using the loading system on “safety” and “blasting efficiency” depending on the presence or absence of filled stemming material. In this paper, the authors report the results of the demonstration experiment.