

首都圏中央連絡自動車道の芝山トンネルは、未固結砂質土、土かぶり3~17mの条件下において延長616m、掘削断面積約80m²を新設するものである。沿線のトンネルではこれまで、流砂現象により地表陥没に至った事例が複数報告されていた。また、本トンネルの直上にはさまざまな土地利用が存在し、地表陥没が起きた場合に利害関係者に与える影響は大きく、掘削時にいかに流砂現象を発生させないかが大きな課題であった。そのほかに、土荷重が支保工脚部に集中し、脚部の地山が不安定化することも懸念されていた。これらの課題に対し、各種の試験施工による対策工の検証を実施したうえで、掘削に臨んだ。その結果、地表構造物に影響を与えることなく、トンネル掘削を無事完了した。本稿ではこれらの対策と結果について述べる。

Overcoming Quicksand and Foot Subsidence with a Small Covering in Unconsolidated Sandy Ground

—The Ken-O Expressway, the Shibayama Tunnel—

By Hisao Kawano, East Nippon Expressway Company Limited

The Shibayama Tunnel on the Ken-O Expressway is a new 616-m-long tunnel with an excavated cross-sectional area of approximately 80 m² constructed in unconsolidated sandy ground with a covering of 3 to 17 m. Several cases of cave-in depression of the ground surface due to quicksand have been reported in tunnels along the expressway. The land directly above the tunnel is used for a variety of purposes. If a surface cave-in depression were to occur, it would have a significant impact on stakeholders, so preventing quicksand during excavation was a major challenge. There was also concern that the soil load would be concentrated on the foot part of the steel supports, destabilizing the ground at the foot part. To address these issues, the excavation was conducted after verifying the measures through various types of test constructions. As a result, the tunnel excavation was completed without any impact on surface structures. In this paper, the authors report on these measures and results.

坂部トンネルは2024(令和6)年度に開通予定の市道日永八郷線~国道477号バイパス間に位置する延長約870mのトンネルであり、そのうち第三期工事は起点側の125mを施工する。坂部トンネルは標高70~80mの未固結地山である丘陵地を貫くトンネル工事であり、トンネル上部にはほぼ全線にわたって営業中のゴルフ場が位置し、最小土かぶりが約3mになる区間があることから、第三期工事の全長でパイプルーフ工を採用した補助ベンチ付き全断面掘削工法による早期閉合が計画された。本稿は、パイプルーフ工の施工計画、施工時の計測管理方法と施工実績、およびトンネル掘削工における地表面沈下抑制対策とその効果の検証について報告する。

Using the Pipe Roof Method to Excavate Directly Under a Golf Course with a Minimum Covering of 3 m

—The National Route 1, the Hokusei Bypass, the Third Phase of the Sakabe Tunnel Project—

By Masakatsu Komiya, Tobishima Corporation

The Sakabe Tunnel is an 870-m-long tunnel between the Hinaga-Yasato municipal road and the National Route 477 bypass, scheduled to open in FY 2024. The third phase of the project will cover the 125 m section closest to the starting point. The tunnel passes through a hilly area of unconsolidated ground at an elevation of 70 to 80 m. Because a golf course in operation is located above the tunnel for almost the entire length and the minimum covering is approximately 3 m in some sections, the early closure was planned for the whole length of the third phase using the full-face method with the auxiliary bench, employing the pipe roof method. In this paper, the authors report on the construction plan for the pipe roof method, the monitoring measurement method during construction and the actual construction results, measures to prevent the subsidence of the ground surface during tunnel excavation, and verification of the effectiveness of these measures.

東京都下水道局は、北区赤羽西地区を重点地区として、浸水対策に取り組んでいる。本工事は、当該地区における雨水排除能力の向上を目的として、既設幹線の増強を図る2本の主要枝線をシールド工法によって施工するものである。上段外径3,340mmと下段外径2,890mmで構成された縦2連地中分岐型のH&Vシールドを用いて、泥水式シールド工法によって同時に発進し、仕上がり内径2,800mm、2,400mmの雨水管を築造するものである。H&Vシールドによる工事は、本工事が国内8例目である。本稿では、この縦2連地中分岐型H&Vシールド工法における発進時の出水対策や縦2連区間部でのシールド姿勢制御などの各種課題について、施工上の対策と実績について報告する。

Tunneling Using Vertical Double Circular H&V Shield TBM Blanching Underground —The Tokyo Sewerage, the Branch Sewer near Akabanedai 1-Chome and Akabane-nishi 4-Chome, Kita City—

By Junichi Karino, Tokyo Metropolitan Government

The Sewerage Bureau of the Tokyo Metropolitan Government promotes inundation prevention measures, focusing on the west area of Akabane, Kita City. The purpose of this project is to improve the stormwater drainage capacity of the area by constructing two main branch sewers using the shield TBM to augment the existing sewer main. The vertical double circular H&V shield TBM branching underground consisted of an upper section with an outer diameter of 3,340 mm and a lower section with an outer diameter of 2,890 mm. Both sections were launched simultaneously using the slurry shield method to construct storm sewer pipes with finished inner diameters of 2,800 mm and 2,400 mm. This is the eighth project in Japan using the H&V shield TBM. In this paper, the authors report on the construction measures and actual results obtained when using this H&V shield TBM, including measures to seal water at the start of construction and shield attitude control in the linked vertical section.

葛西橋通り付近管路は、東京都内の江東変電所から永代橋変電所を連系する内径3.0m、延長6.2kmの長距離シールド洞道の新設工事である。都心部の既設埋設物を回避したルート選定により、トンネルの最大土かぶり53.0m、曲率半径60.0m以下の急曲線部5か所、最大勾配18.55%の大深度・急曲線・急勾配の厳しい施工条件となっている。本工事は2017年3月に着工後、シールド掘進中での巨礫の出現、残置物による縦断線形変更、急勾配施工、到達部の残置物を坑内から人力掘削撤去など、さまざまな課題を解決し、2023年5月に貫通した。その後、急曲線部の二次覆工やケーブル支持用の金物の設置を行った。本稿は、これらの課題解決に関する施工実績について報告するものである。

Construction of a Long Distance, Deep, Steep-Slope Shield Tunnel in Urban Area —TEPCO Pipeline near the Kasaibashi Dori Avenue—

By Ririka Izumi, TEPCO Power Grid, Incorporated

The pipeline near Kasaibashi-Dori Avenue is a new long-distance shield tunnel with an inner diameter of 3.0 m and a length of 6.2 km that connects the Koto substation to the Eitaibashi substation in Tokyo. The route was selected to avoid existing buried structures in the city center, resulting in severe construction conditions with a maximum covering of 53.0 m, five sharp curves with a radius of curvature of 60 m or less, and a maximum inclination of 18.55 %. Various issues were solved during this construction, which began in March 2017 and reached a breakthrough in May 2023, including the appearance of boulders during shield tunneling, changes to the longitudinal alignment due to debris, steep slope construction, and the manual excavation and removal of wastes in the arrival section from inside the tunnel. Subsequently, the secondary lining of sharp curves and hardware for cable support was installed. In this paper, the authors report on construction results related to solving these issues.

高速道路のトンネルはNATMを標準とし、設計・施工の合理化のためNATMデータベースを活用している。本研究は、岩種ごとの変形挙動と支保の変状に着目し、(株)高速道路総合技術研究所のデータベースからトンネル210チューブ、延長300kmを対象として分析した。岩種ごとの変形量を土かぶり、地山強度比、切羽評価点などとの関連性から岩石の特性について考察し、岩種ごとの支保変状を変形量、岩石の特性、支保パターン、変形モードなどとの関連性から、設計・施工上の留意点と課題について述べる。

Study of Characteristic Ground Behavior and Deformation of Supports for Each Rock Type

By Kiyoto Nakano, East Nippon Expressway Company Limited

The standard method to build highway tunnels is NATM, and the NATM database is used to streamline design and construction. Focusing on the deformation behavior and the deformation of supports for each rock type, In this study, the authors analyzed 210 tunnel tubes with a total length of 300 km from the database of the Nippon Expressway Research Institute Company Limited. The amount of deformation for each rock type was analyzed in relation to covering, competence factor, face assessment score, etc. We discuss design and construction issues and points of attention related to the deformation of supports for each rock type in relation to deformation amount, rock properties, support patterns, deformation modes, and other factors.