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大断面シールドトンネルを1.1mの小土かぶりで発進

―横浜環状南線（圏央道）　公田笠間トンネル―

東日本高速道路㈱　村田　賢士

横浜環状南線は，首都圏３環状道路の一つである圏央道の一部を構成する路線で，横浜市金沢区から戸塚区を結ぶ延長約９kmの片側３車線の一般有料道路である．そのうち，公田笠間トンネルは，栄IC・JCT～公田IC間に位置する全長約1.7kmのトンネルで，直径約15mのシールドを往復させて併設トンネルを構築する．また，土かぶり約1.1mの地点からシールドが発進する「小土かぶり発進」という特徴を有している．本稿では，小土かぶり発進に起因する浮上がりや地盤変状といった課題への対応状況に加え，2021（令和３）年12月21日に公表された「シールドトンネル工事の安全・安心な施工に関するガイドライン」の内容を踏まえた工事での取組みについて報告する．

A Large Cross-Sectional Shield Tunnel with 1.1 m of Small Earth Covering at the Starting Point

―The Yokohama Ring Expressway South Line (Ken-O Expressway), the Kuden-Kasama Tunnel―

By Kenji Murata, East Nippon Expressway Company Limited

The Yokohama Ring Expressway South Line is a part of the Ken-O Expressway, one of the three-ring roads in the Tokyo metropolitan area. The approximately 9 km long toll road with three lanes each way connects the Kanazawa ward and the Totsuka ward in Yokohama City. The Kuden-Kasama Tunnel is a 1.7 km long tunnel located between the Sakae IC/JCT and Kuden IC. The tunnel is constructed by driving a shield TBM of approximately 15 m in diameter back and forth. In addition, the TBM started from a point with a small earth covering of just about 1.1 m in thickness. In this paper, authors report on the status of various issues such as uplift and ground deformation caused by small earth cover at the starting point, as well as construction efforts based on the contents of the “Guidelines for Safe and Secure Construction of Shield Tunnels” which were released on December 21, 2021.

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国立公園内のトンネル掘削における環境保全と突発湧水対策

―国道103号奥入瀬バイパス　青ぶな山トンネル避難坑―

国土交通省　佐々木弘幸

青ぶな山トンネル避難坑工事は，国道103号奥入瀬（青橅山）バイパス（全長5.2km）の大部分を占める青ぶな山トンネルに付帯する避難坑（全長4,573m）であり，本工事は子ノ口側からの3,790m区間を掘削するものである．工事場所は十和田八幡平国立公園の奥入瀬渓流北西側に位置し，トンネル全区間が豊かな自然環境を持つ国立公園特別地域内を通過する．施工にあたっては，奥入瀬渓流の魅力の一つとなっている種々の滝への影響を最小限とすることが求められた．地質は十和田火山の噴出物が分布し，各層は固結度が緩く，地下水が豊富に蓄えられており，突発湧水の発生も懸念された．本稿では，国立公園の特別保護区域内のトンネル工事における周辺環境に配慮した施工の取組みと，突発湧水に対する地下水位低下対策について述べる．

Environmental Conservation and Measures against Water Inrush in Tunnel Excavation in National Park

―The National Route 103, Oirase Bypass, Evacuation Tunnel of the Aobunayama Tunnel―

By Hiroyuki Sasaki, Ministry of Land, Infrastructure, Transport and Tourism

A construction project of an evacuation tunnel of the Aobunayama tunnel is to build a 4,573-m-long evacuation tunnel beside the Aobunayama tunnel, which is a major part of the 5.2-km Oirase Bypass（Aobunayama）on National Route 103. The project is an excavation of a 3,790-m-long section from Nenokuchi side. The construction site is located on the northwest side of the Oirase Stream in Towada-Hachimantai National Park. The entire tunnel passes through a special zone in the national park with a rich natural environment. During the construction, it was required to minimize the impact on the various waterfalls that are one of the attractions of the Oirase stream. The ground is composed of volcanic products from Towada Volcano, and the layers are loosely consolidated, with abundant groundwater reserves. There was also concern about the occurrence of water inrush. In this paper, authors describe tunneling efforts in a special protection zone of the national park in consideration of the surrounding environment and measures to lower the groundwater height against water inrush.

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小土かぶりの国道直下を地表と坑内からの補助工法を駆使して突破

―国道118号　鳳坂トンネル―

福島県　影山　嘉一

福島県の中通りと会津を結ぶ国道118号の鳳坂峠付近は，急カーブと急勾配が連続するため，鳳坂トンネル（延長2,538m）が新たに改修工事として計画された．起点側坑口部は，工事用地の制約などから当初の坑口を39m手前に延伸し，国道下を3.5mの小土かぶりでトンネル掘削することになった．トンネル施工が一般交通に与える影響が懸念されたため，類似事例を調べ，FEM解析などにより対策を検討した結果，地表面から地盤改良工，トンネルから長尺鋼管先受け工と鏡補強工の組み合わせ，これらを併用した対策を決定した．本稿は，本対策の検討経緯と施工した結果について報告する．

Breaking Through Directly under a National Highway with a Small Earth Covering Using Auxiliary Methods from the Surface and Inside of the Tunnel

―The National Route 118, the Hosaka Tunnel―

By Yoshiichi Kageyama, Fukushima Prefecture

The Hosaka tunnel（2,538 m long）was planned as a renovation project near the Hosaka pass on National Route 118, which connects Nakadori and Aizu in Fukushima Prefecture because there are continuous sharp curves and steep inclines on the road. Due to site constraints and other factors, it was decided to extend the tunnel by 39 m ahead of the original portal and excavate under the national route with a small 3.5 m earth covering. Since there was concern about the impact of the tunnel construction on general traffic, similar cases were investigated and measures were studied by FEM analysis, etc. As a result, it was decided to use a combination of such measures as ground improvement from the ground surface, forepiling, and face reinforcement from the tunnel. In this paper, the authors present details of the study and the results of the implementation of these measures.

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長距離導水路を最大月進678mのオープンタイプTBMにより施工
―三菱マテリアル　小又川新発電所―

三菱マテリアル(株)　平石　浩一

小又川新発電所は，秋田県北秋田市の米代川水系阿仁川支川小又川に位置する新設水力発電所である．森吉ダム直下の既設小又川第四発電所の放流庭から直接取水し，導水路トンネル延長約8.5kmで下流に設けた発電所に導水し，有効落差91.5mを確保し最大出力10,326kWの発電を行う．この長い小断面導水路トンネルの施工に，φ3.52mオープンタイプTBMを採用した．TBM坑延長が7,658.4mと長いので，高速掘進のために坑内２か所に離合箇所，および２か所に連続ベルトコンベヤのブースタドライブとリターンドライブを配置し，TBMの高速掘進への影響をなくし，最大月進678m，平均月進382.9m，掘削20か月で貫通した．本稿では，高精度かつ高速掘進および地質不良部での確実な施工について，本工事で採用したTBM技術と得られた知見を報告する．

Constructing a Long Distance Headrace Tunnel with Open Type TBM with a Maximum Monthly Advance of 678 m
―Mitsubishi Materials Corporation, the Omatagawa New Power Plant―

By Koichi Hiraishi, Mitsubishi Materials Corporation

The Omatagawa New Power Plant is a new hydroelectric power plant located on the Omatagawa River, a tributary of the Anigawa River in the Yoneshirogawa river system in Kita-Akita City, Akita Prefecture. Water is taken directly from the discharge garden of the existing Omatagawa Power Plant No. 4, which is located directly below the Moriyoshi Dam, and is conveyed through an 8.5 km long headrace tunnel to the power plant located downstream, securing an effective water drop of 91.5 m and generating a maximum output of 10,326 kW. A φ3.52 m open-type TBM was used to construct this long, small-cross-section headrace tunnel. Since the tunnel length to be built with the TBM was 7,658.4 m, two separation points, and two continuous belt conveyor booster drives and return drives were installed in the tunnel for high-speed excavation to eliminate the effect of the TBM on high-speed excavation. The maximum monthly advance was 678 m, the average monthly advance was 382.9 m, and penetration was achieved in 20 months of excavation. In this paper, the authors report on the TBM technology employed in this project and the knowledge obtained regarding reliable excavation in poor geological conditions with high accuracy and high speed.