

新東名高速道路の未開通区間である伊勢原～御殿場間のうち、神奈川県足柄上郡山北町に位置する河内川橋(仮称)工事は、二級河川河内川および観光地である丹沢湖へのアクセス道路を横過する、橋長771m(上り線)の鋼・コンクリート複合バランスドアーチ橋である。構造形式、橋梁規模からも技術的難易度が高く課題も多く存在するため、早期開通を実現するべく、数々の新構造・新工法を活用した合理化施工を進めている。P2、P3橋脚は、急峻な山岳地に位置し、杭径 $\phi$ 16.0～17.0m、掘削長 $L=38.0$ mに及ぶ大口径深礎杭と、高さ $H=76.0\sim 88.0$ mの橋脚からなる国内最大級の規模であり、工程上のクリティカルである。本稿では、P3橋脚の深礎杭掘削にグローリーホール、ずり出し方法にトンネルを活用して合理化した施工について報告する。

### Improving Construction Efficiency of Large-Diameter Deep Foundation of Bridge Using Glory-Hole and Tunnel for Mucking

—The Shin-Tomei Expressway, the Kawachi-gawa Bridge—

By Takuya Harada, Central Nippon Expressway Company Limited

The Kawachi-gawa Bridge (tentative name), located in Yamakita town, Ashigarakami county, Kanagawa Prefecture, is a steel-concrete composite balanced arch bridge with a length of 771 m (upstream), which crosses the Kawachi-gawa river of class B and the access road to Lake Tanzawa, a sightseeing spot, on an unopened section of the Shin-Tomei Expressway between Isehara and Gotemba. Because of the high degree of technical difficulty and since there are many problems arising from the structure and the scale of the bridge, we are proceeding with rationalized construction methods using a number of new structures and techniques in order to achieve early opening of the unopened section. The P2 and P3 piers are located in a steep mountainous area. The piers comprise large diameter deep foundation (caisson type) with diameters of 16.0-17.0 m and excavation lengths of 38.0 m, and columns with heights of 76.0-88.0 m. The piers are one of the largest in Japan and thier construction is critical path for the project. In this paper authors report on the rationalized construction of the P3 pier using a glory hole for foundation excavation and a tunnel for mucking.

冠山峠道路第2号トンネルは、岐阜県揖斐郡揖斐川町～福井県今立郡池田町をつなぐ冠山峠道路事業の一環であり、Ⅰ期工事が2014(平成26)年1月～2017(平成29)年8月に実施され、2017(平成29)年11月からⅡ期工事を継続中である。冠山は標高1,250m、最大土かぶりは720mであり、断層部では大きな土圧が作用し、トンネルの変状が生じるリスクが懸念された。そこで当現場では、さまざまな前方探査技術を活用し、地山性状や分布位置の把握を行い、掘削工事を進めた。一部変状があった区間においては各種の変状対策や計測結果を整理し、その後のトンネル掘削へ反映し、効果を検証した。また、受発注者による支保パターン決定の打合せと位置づけられる「岩判定会議」において、ICTツールを活用し、トンネル工事におけるDXを推進した。

### Prediction of Ground Characteristic Ahead of Tunnel Face and Measures Against Deformation Under Large Overburden and Remote Face Assessment Using DX

—The Kanmuriyama-Toge Road No.2 Tunnel, Second Phase—

By Kazuya Miyakoshi, Ministry of Land, Infrastructure, Transport and Tourism

The Kanmuriyama-toge Road No.2 tunnel is a part of the Kanmuriyama-toge Road project which connects Ibigawa town, Ibi county, Gifu Prefecture to Ikeda town, Imadate county, Fukui Prefecture. First phase of the project was carried out from January 2014 to August 2017, and the second phase has been ongoing since November 2017. The altitude of Mt. Kanmuriyama is 1,250 m and the maximum overburden is 720 m. There was concern about the risk of deformation of the tunnel due to the large earth pressure acting around the fault. The excavation work at the site was carried out using probing techniques ahead of tunnel face to determine the characteristics and distribution of the ground. Various measures against deformation and measurement results which were taken in parts of section where deformation occurred were sifted through to reflect the subsequent tunnel excavation and to verify the effectiveness. In addition, we used ICT tools to promote DX in tunnel construction in "rock classification meetings" positioned as meetings to determine the support pattern by the contractor and contractee.

国道340号の押角峠は、急カーブが多数存在し、雪崩による通行止めが発生するなど交通の難所であった。岩手県では、1947(昭和22)年秋に開業し2014(平成26)年4月に廃線となったJR岩泉線の旧押角トンネル(以下、「既設トンネル」)の大部分を道路トンネルに拡幅整備する計画を立てた。建設に先立つ事前調査では、基準値を超えるヒ素が検出されたため、掘削土は全量封じ込め対策が必要と判断された。本稿では、既設トンネルと新設トンネルの合流区間の施工、既設トンネル覆工背面の空洞部への対処、およびベントナイト混合土を用いた要対策土の封じ込めの施工の概要について報告する。

## Construction of a Road Tunnel by Widening an Abandoned Railroad Tunnel

—The National Route 340, the Oshikado Tunnel—

By Yukitaka Dendo, Iwate Prefecture

The Oshikado Pass on National Route 340 in Iwate Prefecture is a difficult route for transportation due to having many sharp curves and implementation of road closures caused by avalanches. A plan was made to widen most of the abandoned Oshikado Tunnel (hereafter referred to as the "existing tunnel") on the JR Iwaizumi Line, which had been operated from the autumn of 1947 to April 2014, in order to convert it into a road tunnel. In preliminary survey prior to construction execution, arsenic was detected exceeding the standard values, so it was judged to require containment measure against all excavated soil. In this paper we describes outlines: the construction of the junction section of the existing tunnel and the new tunnel, the treatment of the cavity behind the lining of the existing tunnel, the containment for the soil that requires special treatment using a bentonite mixture.

東京電力パワーグリッド(株)では、栃木県佐野市山菅町の葛生変電所を起点に約3kmの地中送電線路を新設する電力供給工事を実施している。このうち、開削工法が困難な東武鉄道の軌道と雨水特殊人孔の横断部、大型車両の交通量が比較的多い国道区間の約580mは、内径800mmの推進工法による管路布設を計画した。掘削地盤は一級河川秋山川沿いの高透水性の玉石混じり砂礫層であり、推進機には泥濃式破砕型を選定した。推進工事の設計施工にあたっては、高透水性地盤や最大径450mmの玉石への対応、長距離推進での推力増による管損傷の防止、無水層地盤におけるテールボイドの安定および各近接施工など多くの課題があった。本稿では、上記の課題を克服した推進工事の設計、施工計画および実績について報告する。

## Design and Construction of Long-Distance Pipe-Jacking in Dry Highly Permeable Sand and Gravel Mixed With Cobble Stones

—Tepco, Pipeline Near the Yamasuge, Sano City—

By Takeshi Fujioka, TEPCO Power Grid, Incorporated

Tokyo Electric Power Grid Co., Inc. is constructing a new 3 km underground power transmission line as a power supply construction project, starting from the Kuzuu Substation in Yamasuge town, Sano City, Tochigi Prefecture. Installation of pipeline with an inner diameter of 800 mm using pipe-jacking was planned, which is applied to a 580 m section under the national route with a relatively heavy vehicle traffic, the Tobu Railway track and a special rainwater manholes where cut-and-cover method is unsuitable. Since geological condition along pipeline is a highly permeable cobble-stone-mixed sand and gravel along the Akiyama River of class A, high-density slurry and crushing cobble stone type excavating machine was selected. In the design and construction of pipe-jacking, there were many problems to be solved, such as measures against highly permeable ground and cobble stones with a maximum diameter of 450 mm, preventing pipe damage due to increased jacking force in long-distance tunneling, stabilizing tail voids in dry ground, and neighboring tunneling. In this paper we reports on the design, construction plan, and results of the pipe-jacking project that overcame the above problems.

山岳トンネルの支保設計で数値解析を用いる場合、地山物性の空間的な不均質性を考慮しないのが一般的である。そのため、解析による予測を大きく超える挙動が現場で生じる場合があるのが現状である。そこで、本研究では、とくに軟岩地山における地山物性の空間的な不均質性を確率場理論にもとづいて考慮した山岳トンネル切羽形成時までのトンネル掘削解析を実施し、地山物性の空間的な不均質性が山岳トンネル掘削時のトンネル挙動に及ぼす影響について評価した。その結果、軟岩地山内の地山物性のばらつきとその空間的な変動の度合いによっては、トンネル周辺変位に及ぼす影響が大きいことがわかった。また、解析結果の変位のばらつきを統計処理することで、地山物性の空間的な不均質性が及ぼす影響を定量的に示すことができた。

### The Effects of Spatial Heterogeneity of Ground on Behavior of Mountain Tunnels During Excavation

By Yasuyuki Okazaki, National Institute of Technology, Matsue College

When numerical analysis is used in tunnel support design of mountain tunnels, it is common not to assume that geomechanical properties have spatial heterogeneity. As a result, in some cases, the actual behavior on-site largely exceeds the analytical prediction. In this study we performed tunnel excavation analyses up to completion of a mountain tunnel face taking into account the spatial heterogeneity of geomechanical properties based on random field theory, especially in soft rock ground in order to evaluate the effects of the spatial heterogeneity of geomechanical properties on behavior of mountain tunnels during excavation. As a result, variation in geomechanical properties of soft rock ground and degree of their spatial fluctuation have large effect on displacement around tunnel. In addition, applying statistical processing to variation in displacement of analysis results was able to quantify the effect of spatial heterogeneity of geomechanical properties.