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併設大断面シールドトンネルを離隔0.38mの超近接で施工

―横浜環状南線(圏央道)　桂台トンネル―

東日本高速道路(株)　河井　誠治

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．当該路線の約7割がトンネルや掘割などの地下構造で計画され，そのうち釜利谷JCTから西1.6kmに「桂台トンネル」が位置する．トンネル延長1,320mの併設トンネルであり，直径約15mのシールドを往復させて構築する計画である．併設トンネルの離隔は最大でも1.48mであり全区間が近接施工となる．さらに全体の1/3にあたる約400mは，離隔が0.38mの「超近接施工」となる．本トンネルについては，2022年1月号に計画編を発表しており，本稿ではその施工実績を報告する．

Construction of Twin Large-Section Shield Tunnel with an Ultra-Close Separation of 0.38 m

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

By Seiji Kawai, East Nippon Expressway Company Limited

The Yokohama Ring Expressway South Line is part of the Ken-O Expressway, one of the Three Ring Roads in the Tokyo metropolitan area. This approximately 9-km-long toll road with three lanes in each direction connects Kanazawa Ward and Totsuka Ward in Yokohama City. Approximately 70% of the route is planned to consist of underground structures such as tunnels and trenches. Among these, the “Katsuradai Tunnel”, as a twin tunnel, is located 1.6 km west of Kamariya JCT. The length of the tunnel is 1,320 m. Each tube was constructed by driving a 15-m-diameter shield TBM back and forth. The maximum separation between the tubes is only 1.48 m, and all sections were constructed close together. In addition, about 400 m, or 1/3 of the total length, were constructed “ultra-close” with a separation of only 0.38 m. There is an article about the planning of this tunnel published in the January 2022 issue. In this paper, the construction progress of the tunnel is reported.

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トンネル直上家屋に対する制御発破の適用

―すさみ串本道路　和深西トンネル―

国土交通省　野瀬井雅徳

すさみ串本道路和深西トンネル工事は，トンネル直上約30mに住宅地があり，当初設計の標準発破(電気雷管)では発破による振動が管理目標値を超過することが想定された．そのため制御発破の検討および試験発破を実施し，起爆秒時を現場で任意に設定できる電子雷管eDevⅡを使用することとした．実施工では，自動計測による計測結果にもとづき，発破振動の影響を最小とする最適な起爆秒時の設定を行い，発破振動周波数を高周波域に制御することが数値的にも体感的にも有効となり，住宅地直下の掘削を問題なく実施することができた．

Application of Controlled Blasting for Tunnel Excavation Directly Beneath a Residential Area

―The Susami-Kishimoto Road, the Wabuka-Nishi Tunnel―

By Masanori Nosei, Ministry of Land, Infrastructure, Transport and Tourism

In the Wabuka-Nishi Tunnel construction project on the Susami-Kushimoto Road, a residential area is located approximately 30 m directly above the tunnel. It was anticipated that the use of conventional blasting methods (electric detonators) specified in the original design would result in vibration levels exceeding the control target values. To address this issue, controlled blasting techniques were investigated, and trial blasts were conducted. As a result, eDev II, an electronic detonator that allows the delay time to be arbitrarily set on site, was adopted. During actual construction, optimal delay timing was determined based on vibration data obtained through automated monitoring to minimize the impact of blasting vibrations. Controlling the blasting vibration frequency into a higher frequency range proved effective, as confirmed by both measured data and on site perception, enabling excavation directly beneath the residential area to proceed without issue.

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過去に類のない巨大地下空洞の掘削

—東京大学（岐阜県神岡）ハイパーカミオカンデ地下空洞掘削等工事—

鹿島建設(株)　小渕　考晃

ハイパーカミオカンデは，地下深部600mに直径ϕ69.3m，高さ93.7mと，過去に類のない規模の地下大空洞を掘削する工事である．ECI方式で発注され，設計者とともに施工者が計画・設計段階からプロジェクトに参画し，空洞の安定と工期短縮，コストダウンに取り組んだ．工事は，地下空洞への進入路となるトンネル掘削から開始し，その後2022年10月に地下空洞の掘削に着手した．ECI業務として取り組んだトンネル・地下空洞の施工計画が機能し，空洞天井部（ドーム部）の掘削まではほぼ計画工程どおりに進捗した．しかし，観測水槽となる円筒部掘削時に，設計段階で想定した以上の変形挙動が発生し支保部材の変状が生じた．途中で対策工期間が必要となったが，2025年７月末に地下空洞の掘削を完了した．本稿では，この工事の計画と施工内容について報告する．

Excavation of an Unprecedented Large-Scale Underground Cavern
—Construction of the Hyper-Kamiokande Underground Cavern, University of Tokyo (Kamioka, Gifu Prefecture)—

By Takaaki Kobuchi, Kajima Corporation

The Hyper-Kamiokande project involves the excavation of an unprecedented large-scale underground cavern located approximately 600 m below ground level, with a diameter of 69.3 m and a height of 93.7 m. The project was commissioned under the Early Contractor Involvement (ECI) model, with the contractor participating in the project alongside the designer from the planning and design stages to ensure the stability of the cavern, shorten the construction period, and reduce costs. Construction began with the excavation of access tunnels leading to the underground cavern, followed by the start of the excavation of the cavern itself in October 2022. The construction planning for both the tunnels and the cavern, developed as part of the ECI process, functioned effectively, and excavation progressed largely in accordance with the planned schedule up to the excavation of the cavern ceiling (dome section). However, during excavation of the cylindrical section, which serves as the observation tank, deformation behavior exceeding initial design assumptions was observed, resulting in distortion in the support members. Although additional time was required to implement countermeasures, excavation of the underground cavern was successfully completed by the end of July 2025. This paper reports on the planning and construction details of this project.

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鉄道トンネルの壁面画像を用いた検査支援技術の開発

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鉄道トンネルでは２年に１度の全般検査を熟練検査員の目視・打音で実施しているが，今後の労働人口の減少が見込まれており，デジタル技術を活用などによる省人化が重要な課題となっている．本研究では，鉄道トンネルにおいて，連続的に撮影した壁面画像を活用し，検査作業を支援する２つの技術を構築した．１つ目は変状と補修跡をAIで自動検出し健全度を判定するアプリで，人手作業を確認・修正に限定でき，台帳整理の労力削減が期待できる．２つ目は要注意箇所を壁面に投影表示する装置で，紙資料との照合作業を不要とし，現地での位置特定を容易にする．現行のすべて人手による検査方法と比較検証したところ，作業効率の向上に寄与することを確認した．

Development of Inspection Support Technologies Using Wall Surface Images for Railway Tunnels

By Takashi Nakayama, Railway Technical Research Institute

In railway tunnels, comprehensive inspections are conducted every two years through visual inspection and hammering tests by experienced inspectors. However, with the anticipated decline in the labor force, reducing manpower requirements through the utilization of digital technologies has become an important issue. In this study, two inspection support technologies were developed using continuously captured wall surface images in railway tunnels. The first is an application that automatically detects deformations and repair marks using AI and evaluates structural conditions. This approach limits human involvement to verification and correction tasks and is expected to reduce the workload required for database management. The second is a system that projects locations requiring attention directly onto the tunnel wall surface, eliminating the need for cross-referencing with paper documents and facilitating on-site localization. Comparative validation against conventional fully manual inspection methods confirmed that the proposed technologies contribute to work efficiency improvement.