施工 07

開業50年経過した東海道新幹線におけるトンネルの大規模改修

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東海道新幹線は全線515.4kmのうち68.6kmをトンネルが占めている．1964(昭和39)年の開業以降50年以上経過しているが，トンネルを含めた土木構造物は入念な検査や補修の積み重ねにより十分な健全性を保ち続けている．一方，経年による老朽化の進行が課題とされ，いずれは設備の取替やそれと同等の効果を有する大規模な改修が必要になると考えられたことから，全トンネルを対象に，「予防保全」として変状の発生を抑止する対策を講じ，構造物の性能を可能な限り現状維持することとした．2013(平成25)年より大規模改修に着手し，現在も工事を実施中である．本稿では，JR東海におけるトンネルの大規模改修の概要と施工事例を報告する．

Large Scale Renovation of Tunnels on the Tokaido Shinkansen After 50 Years of Service

By Toru Suzuki, Central Japan Railway Company

Tunnels make up 68.6 km of the Tokaido Shinkansen whose full length is 515.4 km. More than 50 years have passed since the Railway opening in 1964, but civil engineering structures, including tunnels, continue to maintain sufficient soundness through careful inspections and repairs. Nevertheless, the progression of aging is an issue that will eventually require the replacement of facilities or large-scale renovation with equivalent effectiveness. "Preventive maintenance" was performed on all tunnels to prevent the occurrence of deformations and to maintain the performance of the structures in their current state as much as possible. The large-scale renovation was started in 2013 and the works are still underway. In this paper, the authors describe the large-scale tunnel renovation project executed by Central Japan Railway Company and present renovation examples.

施工 17

含水未固結地山のⅡ期線トンネルにおける地下水と変位抑制対策

―金沢東部環状道路　月浦トンネル(Ⅱ期線)―

国土交通省　渡部　秀樹

月浦トンネルⅡ期線工事は，金沢東部環状道路(延長9.4km)のうち，4車線開通に向けて工事中の金沢市月浦町から金沢市神谷内町間にある延長1,020mのトンネルを構築するものである．開通済みのⅠ期線と離隔20mの近接施工であることから，Ⅰ期線の安全確保が最重要課題であった．本工事では通常の計測工Aのほかに，坑口部の周辺およびⅠ期線トンネル内にさまざまな計測機器を設置し，地山挙動の常時監視を行いながら，掘削延長1,006mを機械掘削によるNATMで施工した．本稿では，含水未固結地山のトンネル掘削において実施した水抜きボーリングなどの地下水対策，一次インバートなどの変位抑制対策，Ⅰ期線トンネルの計測監視などについて報告する．

Groundwater and Displacement Control Measures in Phase Ⅱ Tunnels in Hydrous Unconsolidated Ground

―Kanazawa Eastern Ring Road, the Tsukiura Tunnel (Phase Ⅱ)―

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

The Tsukiura Tunnel Phase II construction project includes the construction of a 1,020 m long tunnel between Tsukiura-machi and Kamiyachi-machi in Kanazawa city, which is a part of the Kanazawa Eastern Ring Road (9.4 km long). The goal of the project is to allow traffic on four lanes. The most critical issue was to ensure the safety of the Phase I tunnel because the new tunnel was separated from the already opened Phase I tunnel by a distance of 20 m. In addition to the usual measurement items A, various measuring instruments were installed around the tunnel portals and in the Phase I tunnel to constantly monitor the behavior of the ground while the 1,006 m section was excavated using mechanical excavation by NATM. In this paper, the authors report on groundwater control measures such as dewater boring, displacement control measures such as lining primary invert concrete, and monitoring of the Phase I tunnel during the tunnel excavation in an unconsolidated ground.

施工
49

硬質花崗岩での小断面NATM導水路および発電所立坑の施工

―中部電力　清内路水力発電所―

中部電力(株)　上田　雅司

中部電力(株)では，長野県南部の飯田市および下伊那郡阿智村において流れ込み式の清内路水力発電所を建設中である．本工事では，総延長約5,100m，内空約 6 m^2の導水路トンネルを計画し，小断面かつ地山が良好な花崗岩であったことからNATMを採用した．施工にあたってはレール方式を採用し，削孔機材やずり出し機材，吹付け機材などを工程ごとに編成を変えて行った．また，工程短縮やコスト削減のためにトンネル内面はコンクリート吹付けを仕上がり面とした．一方，発電所では最大出力5,600kWに必要な有効落差約273mを得るため，内径12.4m，深さ約30mの円筒形立坑を計画し施工した．本稿では，花崗岩の小断面掘削にレール方式を用いたNATMおよび発電所立坑の施工実績を報告する．

Construction of Small NATM Headrace Tunnel and Power Plant Shaft in Hard Granite
―Chubu Electric Power, the Seinaiji Hydroelectric Power Plant―

By Masashi Ueda, Chubu Electric Power Co.,Ltd.

Chubu Electric Power Company is constructing an inflow type Seinaiji hydroelectric power plant in Iida City and Achi Village in the southern part of Nagano Prefecture. This project includes the construction of a headrace tunnel with a total length of approximately 5,100 m and an inner section area of approximately 6 m^2. The small cross-section and good condition of the granite ground allowed to adopt the NATM. Rail haulage was used in the tunneling. Drilling, mucking, and spraying machines were changed for each process. To shorten the duration and reduce costs, the sprayed concrete lining was used as the finished surface. In addition, a cylindrical shaft with an inner diameter of 12.4 m and a depth of approximately 30 m was designed and built to obtain an effective head of approximately 273 m, which is required for the maximum output of 5,600 kW of the power plant. In this paper, the authors report the results of the construction of the small tunnel using NATM with rail haulage in granite ground, as well as the construction of the power plant shaft.

施工
61

狭小環境における立坑築造と高水圧下でのシールド到達

―東京都水道局　配水本管河川横過事業―

東京都　下田　利幸

中川水管橋の代替路線として，中川を横断するトンネル築造をシールド工法により施工した．発進立坑は，周辺家屋と近接していることから周辺地盤に与える影響を最小限に抑える必要があり，工法検討を行った結果，アーバンリング工法での築造となった．一方，到達立坑は，道路幅員8.7mの狭小な場所に位置しており，路面覆工を設置したのち，鋼矢板で築造した路下ヤード内にアーバンリング工法の沈設設備を配置し，路下施工により28mの深さで築造した．シールド到達時には，地下水圧が高く，湧水や土砂の流出が懸念されたため，到達立坑内に隔壁（バルクヘッド）を事前に設置し，その中にシールドを到達させる方法で施工した．

Construction of Shaft in a Narrow Environment and Arrival of Shield TBM under High Water Pressure

―Water Distribution Main Pipe River Crossing Project, Bureau of Waterworks, Tokyo Metropolitan Government―

By Toshiyuki Shimoda, Tokyo Metropolitan Government

A tunnel was constructed across the Nakagawa River using the shield tunneling method as an alternative route to the Nakagawa Aqueduct Bridge. After a study of various construction methods for the launching shaft, the urban ring construction method was selected to minimize the impact on the surrounding ground since the shaft was located close to residential houses. The arrival shaft was located in a narrow space with a road width of 8.7 m. After the road decking was installed, the shaft was constructed under the road to a depth of 28 m by placing the immersion equipment of the urban ring method in an underground yard constructed with steel sheet piles. Because the groundwater pressure was high at the time of shield TBM arrival and there were concerns about water inflow and sediment runoff, the shield TBM arrived at the shaft in which a bulkhead was installed in advance.