

急峻な山間部の坑口掘削と大山火山起源の堆積物を含むトンネル地山の施工
—米子自動車道 谷川トンネル・添谷トンネル—

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米子自動車道谷川トンネル他1トンネル工事は、米子自動車道4車線化事業のうち江府IC～溝口IC間のⅡ期線高速道路を施工するものである。本工事は谷川トンネル、添谷トンネル、橋梁下部工、橋梁上下部工、土工区間がある延長2.3kmの工事である。本稿は谷川トンネル、添谷トンネルの到達側坑口が急峻な谷地形にあり、坑口処理の検討とセーフティークライマー工法などを用いた坑口掘削について報告する。また、高低差がある土地での仮設備計画を要する山岳トンネル工事の施工と大山火山起源の噴出物、二次堆積物を掘削中に発生した切羽での約300m³の地山崩落の対策工について報告するものである。

Excavation of Tunnel Portals in Steep Mountainous Areas and Tunnel Groundwork Involving Volcanic Sedimentary Deposits from Mount Daisen**—The Yonago Expressway, the Tanigawa Tunnel, and the Soedani Tunnel—****By Koji Morii, West Nippon Expressway Company Limited**

Construction of the Tanigawa Tunnel and another tunnel on the Yonago Expressway is a part of the Yonago Expressway 4-lane expansion project, which involves construction of the second phase of the expressway between Kofu IC and Mizoguchi IC. This 2.3-km project includes the Tanigawa Tunnel, the Soedani Tunnel, substructures and superstructures of bridges, and earthwork sections. This paper reports on the challenges of the excavation of the arrival-side portals of both the Tanigawa tunnel and the Soedani tunnel, which are located in steep, narrow valleys. The portals were excavated using the safety climber method. The paper also discusses construction planning for mountain tunnels that require temporary facilities on terrain with significant elevation differences, as well as measures implemented in response to a collapse of approximately 300 m³ of ground at the tunnel face during excavation of volcanic ejecta and secondary deposits originating from Mt. Daisen.

安全で合理的なトンネル掘削を進めるために変位計測は不可欠である。切羽を開放し支保を設置した際、最終的な変位がどの程度まで進むかは掘削に携わる技術者にとって大きな関心事である。事前の地質調査に制約のある大土かぶりの場合や、計画時に想定した地質状況が施工時と大幅に異なる場合などに、初期変位計測は高い効果を発揮する。本研究では、初期変位から最終変位を予測でき、その予測にもとづいて迅速かつ適切な施工判断を下せることを実計測データや支保パターン変更事例により示す。1サイクル変位計測は通常、切羽開放後10～16時間以内に予測結果を得られるため、早い段階での地山挙動把握、支保妥当性評価、および支保パターン変更の判断にとって有用である。

A Study on the Effective Use of Initial Displacement Measurements

—The Chuo Shinkansen, the Minami-Alps Tunnel, the Yamanashi Lot, and others—
By Takeshi Sato, Central Japan Railway Company

Displacement monitoring is essential for the safe and rational excavation of tunnels. When the tunnel face is opened and supports are installed, estimating the final displacement is a major concern for tunneling engineers. Measurements of the initial displacement are particularly effective in situations where the prior geological surveys are limited due to a large soil cover or when actual ground conditions during construction differ significantly from those assumed in the planning stage. This study demonstrates, using actual measurement data and examples of support pattern changes, that final displacement can be predicted from initial displacement, enabling quick and appropriate construction decisions. Since one-cycle displacement measurements typically provide predictive results within 10 to 16 hours after the tunnel face is opened, they are very useful for early understanding of ground behavior, evaluation of support adequacy, and making decisions about changing support patterns.

山岳トンネル工事の切羽観察は、切羽に接近して行われるため、落石事故の危険性が伴うことや評価者の経験により大きく左右されることから、切羽評価の高度化・自動化が求められており、近年はAIを用いた画像診断技術の発展に伴い、切羽写真を解析し亀裂状況の抽出などの試みがなされている。本研究では、人間の視覚では捉えられない情報も取得できるハイパースペクトルカメラを用いて凝灰角礫岩のトンネルの複数の切羽でマルチスペクトル画像の撮影・解析を行い、解析結果について画像処理を行った。本稿では、画像解析および画像処理の結果、切羽に接近せずに遠方からの撮影だけで地質技術者による地山の風化度合いの観察結果と同様の結果が得られることがわかったので報告する。

Improving Tunnel Face Evaluation Using Hyperspectral Image Analysis

By Hitoshi Tezuka, Kumagai Gumi Co., Ltd.

Since face observation in mountain tunneling involves the risk of falling rocks due to the close proximity to the tunnel face and largely depends on the evaluator's experience, there is a need for more advanced and automated face evaluation. In recent years, with the development of image diagnosis technology using AI, there have been some attempts to analyze photographs of the tunnel face and extract crack conditions. In this study, a hyperspectral camera—capable of capturing information beyond the range of human vision—was used to take and analyze multispectral images of multiple tunnel faces in tuff breccia, and image processing was performed on the analysis results. The results of the image analysis and image processing show that the same results as those obtained by a geological engineer's observation of the degree of weathering of the ground can be obtained by simply taking images from a distance without approaching the tunnel face.

報告

令和 6 年能登半島地震で被災した中屋トンネルの復旧

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国土交通省 西野 達朗

国道249号は、石川県七尾市を起点とし、能登半島を周回し輪島市を経由して金沢市に至る、能登の産業・経済・観光を支える一般国道である。中屋トンネルは、1993(平成5)年に供用された石川県輪島市と旧門前町を結ぶ延長1,259.5mの2車線の山岳トンネルで、令和6年能登半島地震により覆工の崩落を伴う被害が生じた。本稿は、損傷を受けた覆工の崩落や支保工の変状などの損傷事例と、その後の調査によって得られた支保工の変状状況について報告するとともに、損傷に応じて実施した復旧工事について報告するものである。

**Restoration of the Nakaya Tunnel Damaged by the 2024 Noto Peninsula Earthquake
By Tatsuro Nishino, Ministry of Land, Infrastructure, Transport and Tourism**

National Route 249 is a general national highway that originates in Nanao City, Ishikawa Prefecture, loops around the Noto Peninsula, passes through Wajima City, and continues to Kanazawa City. This route supports the region's industry, economy, and tourism. The Nakaya Tunnel, a 1,259.5-m-long 2-lane mountain tunnel connecting Wajima City and the former Monzen Town in Ishikawa Prefecture, was opened in 1993. It sustained severe damage, including the collapse of its lining, during the 2024 Noto Peninsula Earthquake. This paper reports the observed damage, such as the collapse of damaged lining and deformation of support structures, as well as the state of deformation of the support structures as determined through subsequent investigations. It also reports on the restoration works conducted in response to the damage.