Tunnel Structure for Special Ground Conditions

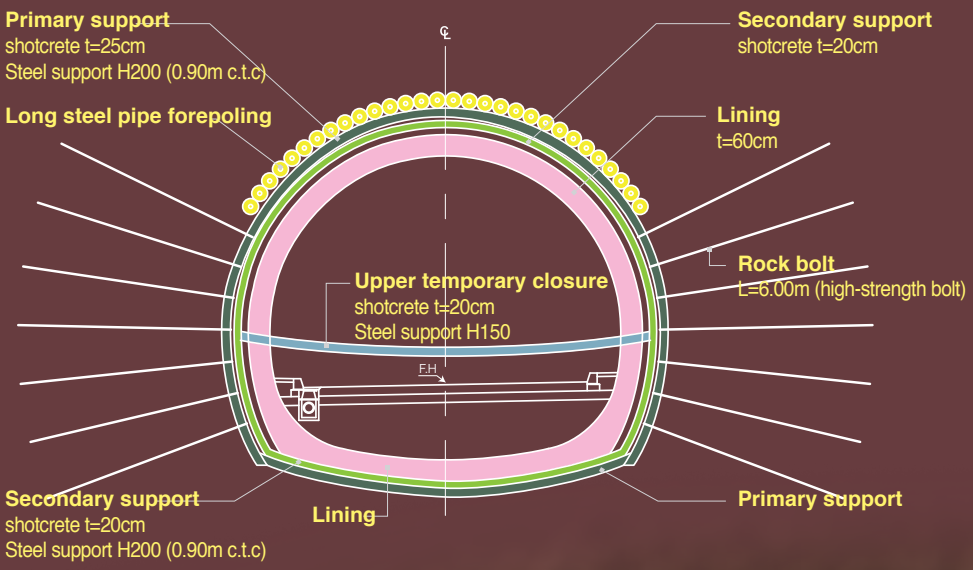
特殊な地山条件におけるトンネル構造

▶ Tunnel Structure under Strong Earth Pressure related to Movable Ground

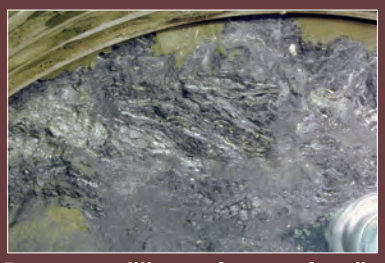
In tunnel excavation in areas with super-fragile geology thought to be related to movable ground, deformation or damage has occurred to shotcrete and rock bolts due to the action of strong earth pressure. As a response to such earth pressure, we adopted a highly durable tunnel structure with doubled supporting components.

●移動性地山に関係する強大な土圧下のトンネル構造

移動性地山に関係すると思われる超脆弱地質でのトンネル掘削において、強大な土圧作用による吹付コンクリートやロックボルトの変状・破損が発生しました。このような土圧への対応として、支保部材を二重とする耐久性の高いトンネル構造を採用しました。



Details of double-support structure to counteract strong earth pressure

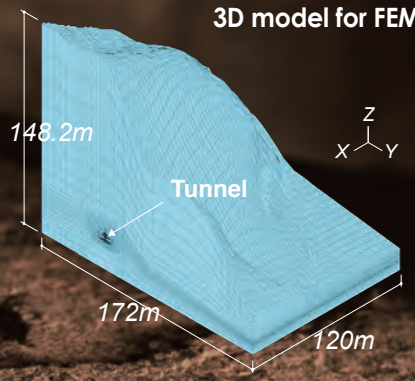


Face conditions of super-fragile geology

Damage to rock bolt (left) and crack in shotcrete (right) caused by action of strong earth pressure

▶ Examination of Impact on Bedrock Collapse via 3D FEM Analysis and Judging Necessity of Supplementary Method

We conducted 3D finite element method analysis that reflects the progression of the tunnel face, in order to evaluate the impact of tunnel excavation on a slope which has similar conditions to terrain or geological features where large-scale bedrock collapse has occurred, and to judge whether a supplementary method is necessary. Virtually no differences in stress in the tunnel's loosened area or surroundings were recognized with or without a supplementary method, thus the construction work was safely completed without using a supplemental method.

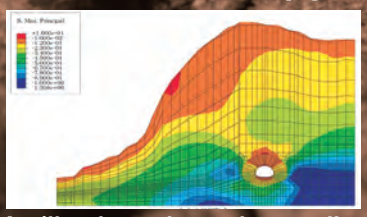


3D model for FEM

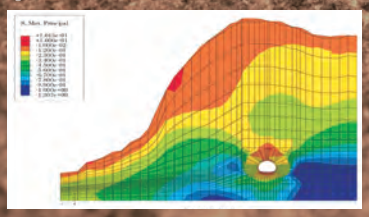
●三次元FEM解析による岩盤崩壊への影響評価と補助工法の要否判定

大規模な岩盤崩壊が発生した地形地質と同様な条件を持つ斜面において、トンネル掘削の影響評価と補助方法の要否判定を行うため、トンネル切羽の進行を反映できる三次元有限要素法解析を実施しました。補助工法の有無でトンネルの緩み域や周辺の応力に違いはほとんど認められず、補助工法なしで無事工事が完了しました。

Analysis results:
Color-coded principle stress diagram, no differences observed between (a) and (b)



a) without supplementary method



b) with supplementary method

Cost Reduction Technique for Disposal of Tunnel Excavation Waste Containing Heavy Metals

重金属を含むトンネルずり処理のコスト低減化技術

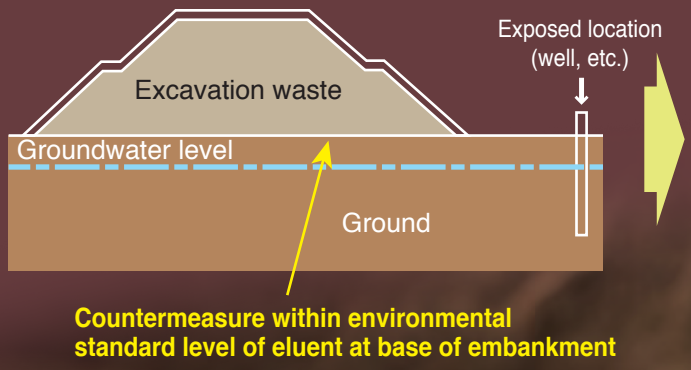
In recent years, we have been using risk assessment to investigate measures conducted on excavation waste (of natural origin) containing heavy metals. While previously-adopted countermeasure methods (seepage control work, insolubilization methods, etc.) deal only with excavation waste, risk assessment enables us to account for effects (retardation of heavy metals, etc.) on the ground (unconsolidated sediment), making it possible to adopt a more economic countermeasure method.

In risk assessment, we construct a model of the hydrogeology of the area surrounding the embankment spot, and use advection-dispersion analysis to find the density of heavy metal waste and other substances in an exposed location (a well, etc.). We investigate countermeasures with the condition that the density of heavy metals at the exposed location must be within the environmental standard density.

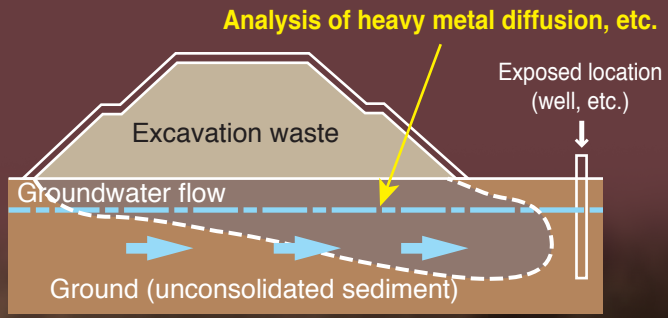
近年の重金属を含む掘削ずり(自然由来)の対策は、リスク評価を用いた検討を行っています。以前より採用されている対策工法(遮水工、不溶化工法等)は掘削ずりのみへの対策になりますが、リスク評価では地盤(未固結堆積物)の効果(重金属拡散の遅延等)を見込めるため、より経済的な対策工の採用が可能となります。

リスク評価は、盛土箇所周辺の水理地質のモデルを構築し、曝露地点(井戸等)における重金属ずり等の濃度を移流分散解析により求めます。対策は、曝露地点の重金属濃度が環境基準以下となる点を条件として検討を行います。

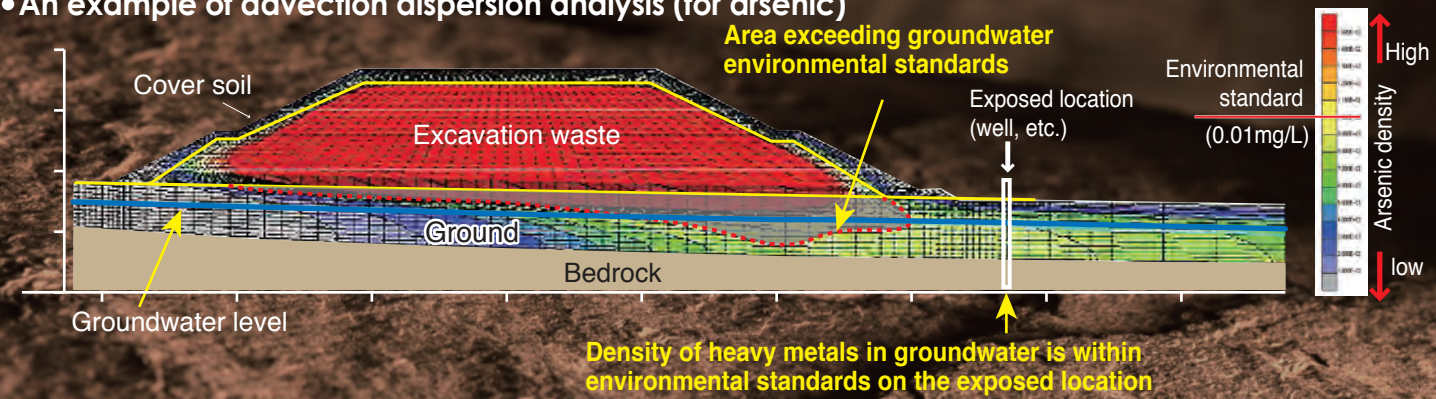
•Countermeasure using seepage control work, insolubilization methods, etc.



•Countermeasure using risk assessment



•An example of advection dispersion analysis (for arsenic)



Docon Co., Ltd.
1-5-4-1, Atsubetsu-chuou, Atsubetsu-ku, Sapporo 004-8585, Japan
Telephone : +81-11-801-1500 (main number)
E-mail: info@docon.jp URL : **www.docon. jp**

総合建設コンサルタント
株式会社ドーコン
札幌市厚別区厚別中央1条5丁目4-1
TEL. 011-801-1500 (代) FAX. 011-801-1600

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