

長尺鏡止めボルトによる

# トンネル切羽補強工法

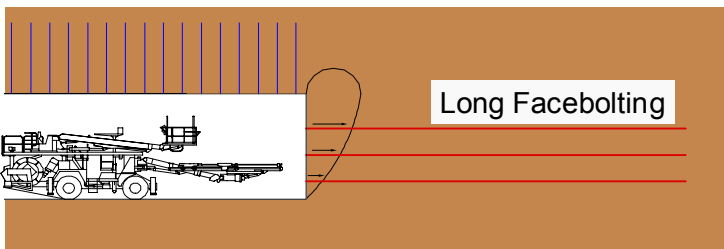
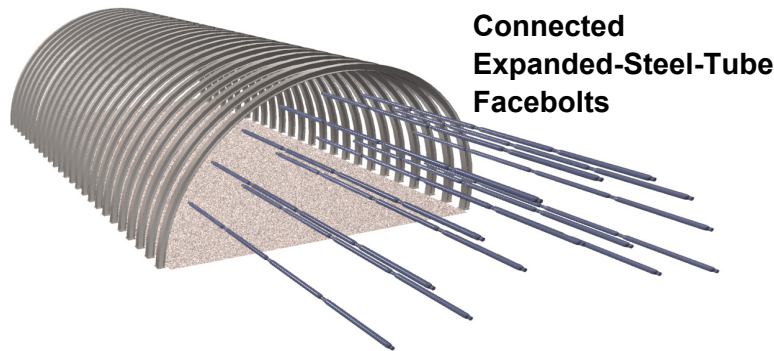
— 計測・解析による補強効果の評価 —

## Tunnel Face Reinforcement Method by means of Long Facebolts

- Estimation of Reinforcement Effects by Measurements & Numerical Analyses -

### ●長尺鏡止めボルト工法

Tunnel Face Reinforcement Method with Long Facebolts



### ●ボルトの種類

Types of Facebolts

長尺鏡止めボルト工法は、軟弱地山におけるトンネル切羽の押し出し変位を抑制し、安定化させる工法です。これにより、大型汎用機械の使用が可能になり、効率的な施工が可能になります。

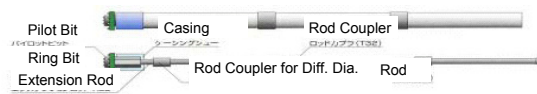
The tunnel face is reinforced by means of long facebolts so as to restrain the extrusive displacement at the face and consequently to stabilize the face. This tunneling method enables the use of large construction machines resulting in effective tunneling.

Types of Facebolts

●GFRP Rockbolt - Hollow/Solid,  $\phi 30.5$



●GFRP Tube Bolt -  $\phi 76$



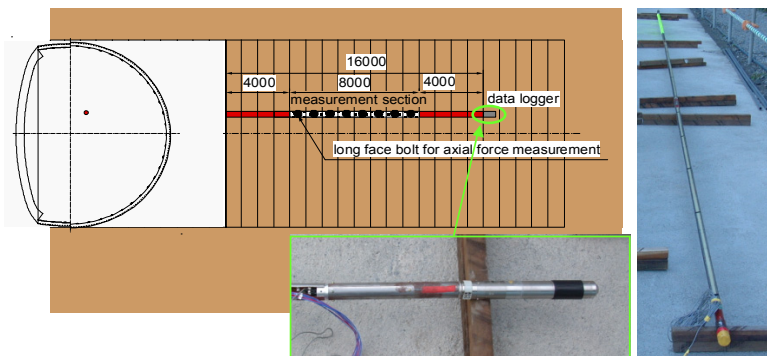
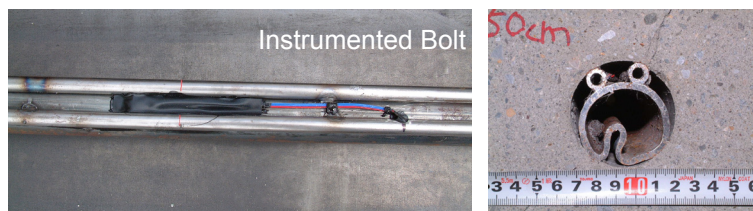
●Connected EST Rockbolt -  $\phi 46$



### ●原位置計測—長尺鏡止めボルトの軸力測定

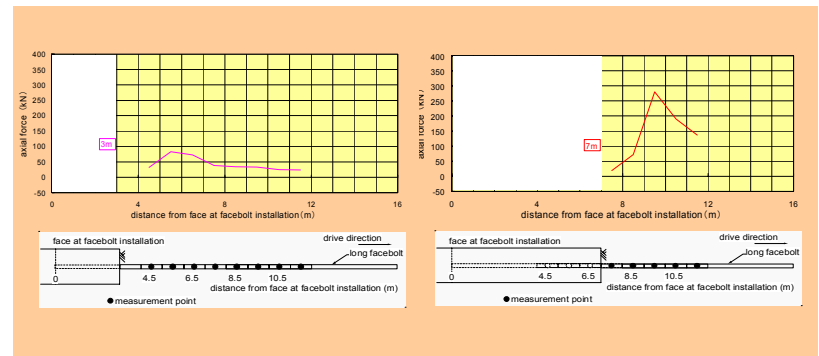
In-situ Measurement: Axial Force Distribution of a Long Facebolt

#### Connected Expanded-Steel-Tube (EST) Facebolt



切羽に打設したボルトに発生する軸力分布を測定し、長尺鏡止めボルトの補強効果を検証します。連結式鋼管膨張型ボルトの軸力計を新たに開発し、トンネル切羽に打設した長尺鏡止めボルトに発生した軸力分布変化を計測しました。

The reinforcing effects of the facebolts are verified by measuring the distribution of axial forces along the facebolt installed at the face. A novel method to measure the axial forces of a connected expanded-steel-tube facebolt has been developed and applied to a tunnel face.



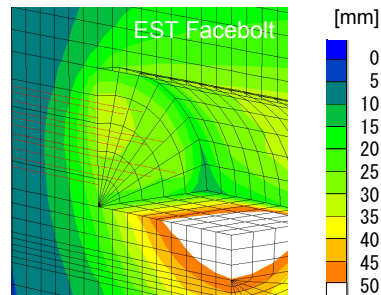
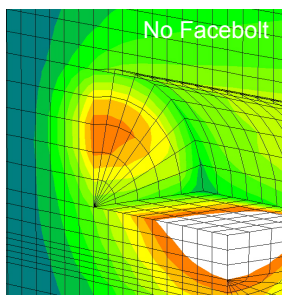
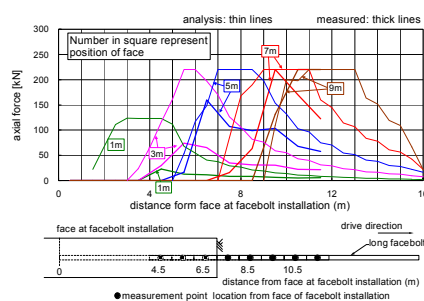
### ●三次元解析による補強効果の評価

Estimation by 3D Analyses

三次元数値解析で計測した軸力分布を良好に表現できます。ボルト有無解析比較により切羽の変位抑制効果を定量的に検討します。

3-Dimensional numerical analysis can express the measured axial force distribution.

The reinforcement effects can be quantitatively investigated with the analyses with and without facebolts.



### ●補強効果の予測解析

Prediction Analyses

ボルトの種類を変えた解析で、補強効果を予測します。

The reinforcement effects of different types of facebolts can be estimated with the 3-dimensional analyses.

