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We applied HMP on the slope in exit of the tunnel.

We executed the field measurement.

I will present result of it.

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Contents

1. Background & Outline of the Construction
2. Purpose of Field measurement
3. Field measurement result of High Capacity Micropiles
4. Conclusion

I would like to speak four contents.

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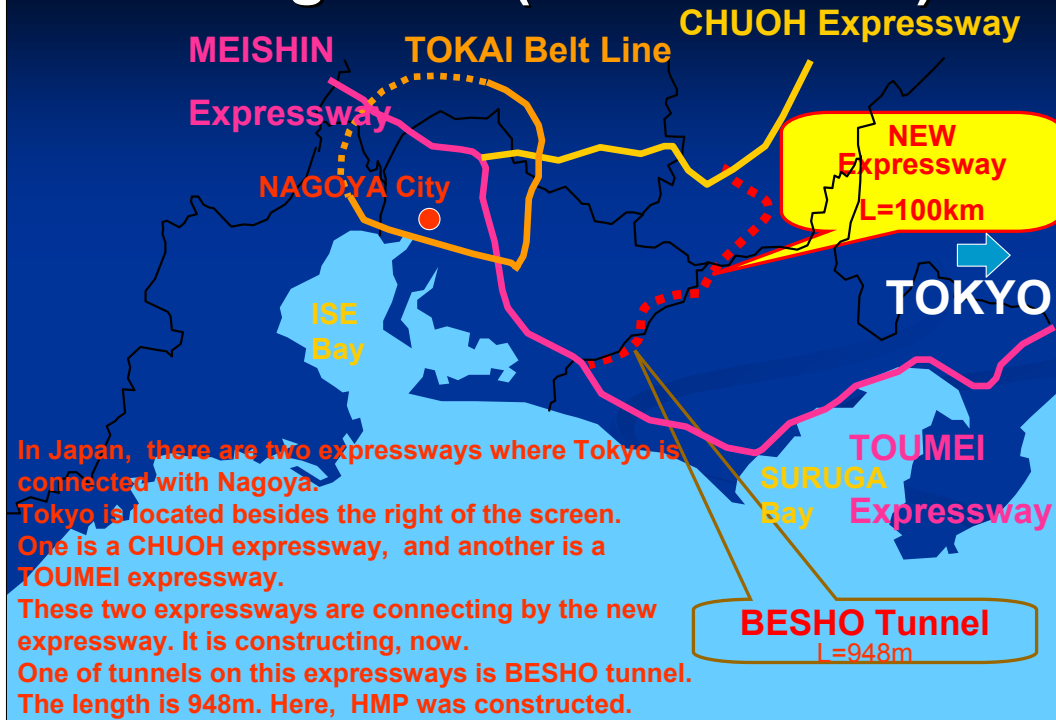
Background(Site location)



This is the site location from Google Earth.
It is a site of the tunnel construction.
The name is called BESHO tunnel.

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Background(Site location)



In Japan, there are two expressways where Tokyo is connected with Nagoya.

Tokyo is located besides the right of the screen.

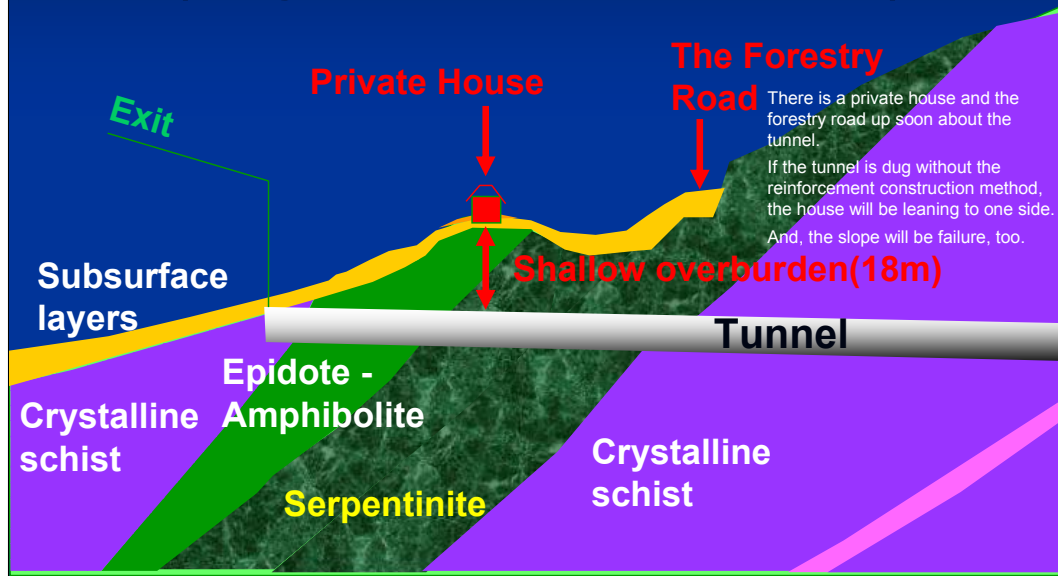
One is a CHUOH expressway, and another is a TOUMEI expressway.

These two expressways are connecting by the new expressway. It is constructing, now.

One of tunnels on this expressways is BESHU tunnel.

The length is 948m. Here, HMP was constructed.

Outline of the Construction Exit of tunnel terminal side (longitudinal vertical section)



This figure is a longitudinal vertical section of the tunnel.

There is a private house and the forestry road up soon about the tunnel.

If the tunnel is dug without the reinforcement construction method, the house will be leaning to one side.

And, the slope will be failure, too.

Countermeasure Against Landslide and Tunneling

For Slope Stability

The three countermeasures were applied for the slope stability.

- Extension of entrance of tunnel(8m)

- Rock Bolt

- High Capacity Micropile with Ground Anchor

HMP with the ground anchor were constructed to a large-scale slope failure.

The lock bolt was constructed to a small slope failure.

For Tunnelling

All Ground Fasten Method (AGF)

All Ground Fasten Method was applied to the tunneling.

Like this, a small slope failure and a large-scale slope failure were forecast.

However, the exit of the tunnel has been extended.

As a result, the amount of cut has been reduced.

In the first plan, the exit of the tunnel was here. And, it was scheduled to be cut.

This figure shows countermeasure against landslide and tunneling.

All Ground Fasten Method was applied to the tunneling.

And, three countermeasures were applied for the slope stability.

In the first plan, the exit of the tunnel was here.

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Like this, a small slope failure and a large-scale slope failure were forecast.

The lock bolt was constructed to a small slope failure.

HMP with the ground anchor were constructed to a large-scale slope failure.

Construction position in ground plan



This figure shows the construction position of HMP.

HMP was constructed near the tunnel.

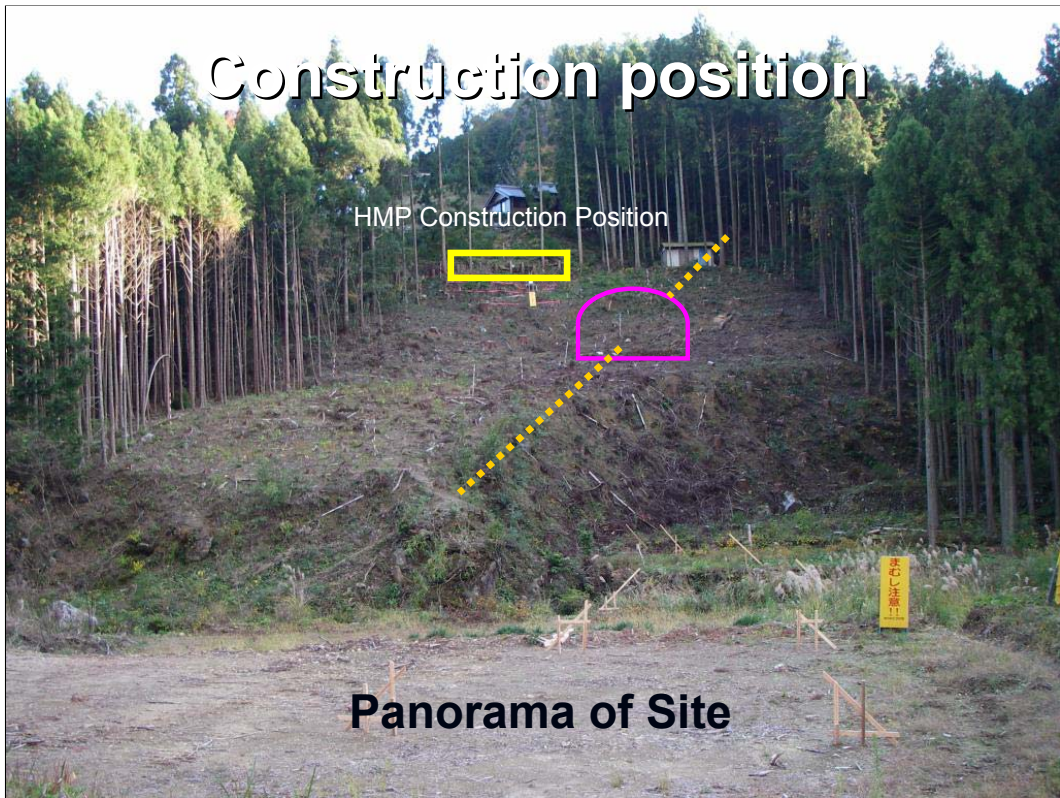
11 piles were constructed.

The length is from 13 to 17m.

The total length is 149m.

Construction position

HMP Construction Position



Panorama of Site

Drilling situation



Drilling completion



Connection of Pile head



HMP seen from mountain side



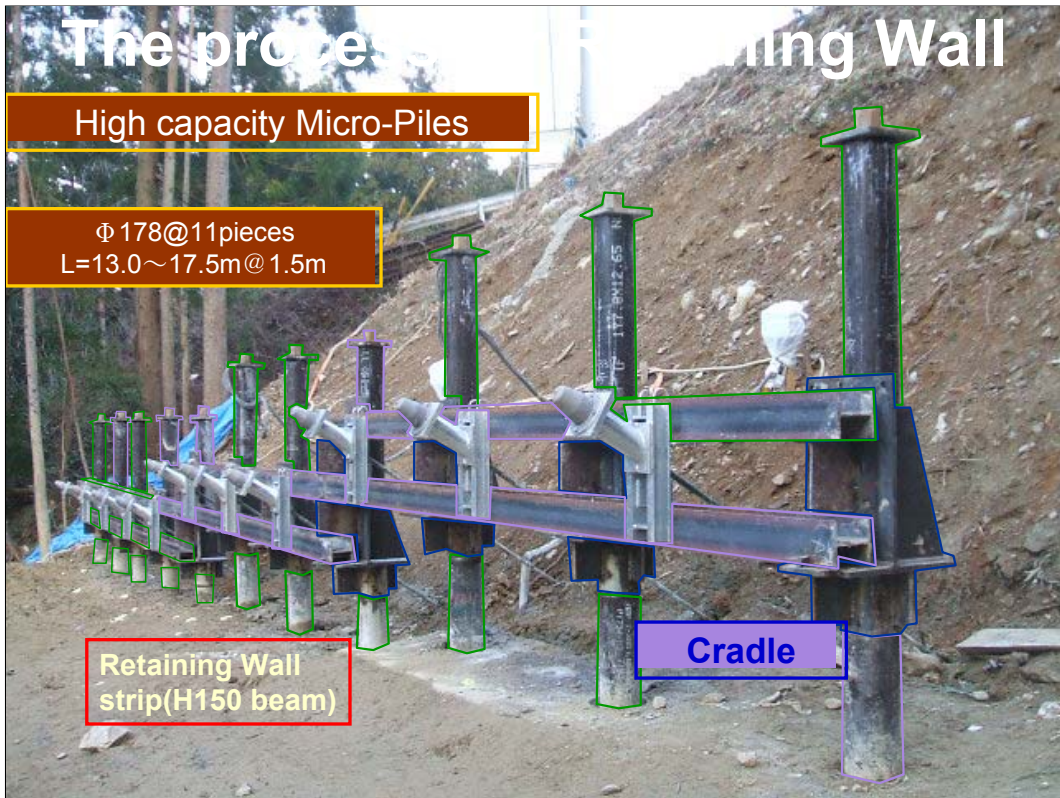
The process of Building Retaining Wall

High capacity Micro-Piles

$\Phi 178@11$ pieces
L=13.0~17.5m@1.5m

Retaining Wall strip(H150 beam)

Cradle



The process for Retaining Wall (Placing of reinforcement)



The process for Retaining Wall (Concrete placement)



Purpose of field measurement

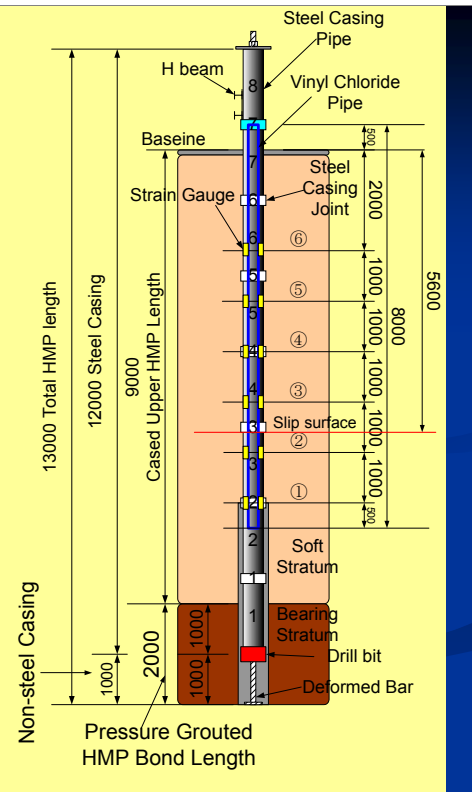
- We aim to confirm the effect of HMP control works on the slope.



- The strain gauges were put on HMP, and the bending moment was measured on the site.

Measurement Piles

- The vinyl chloride pipe with the strain gauges was set up in the steel pipe.
- The strain gauges of installation sections were six places.



This is an outline of the measurement piles.

In this case, the vinyl chloride pipe with the strain gauges was set up in the steel pipe.

The strain gauges of installation sections are six places.

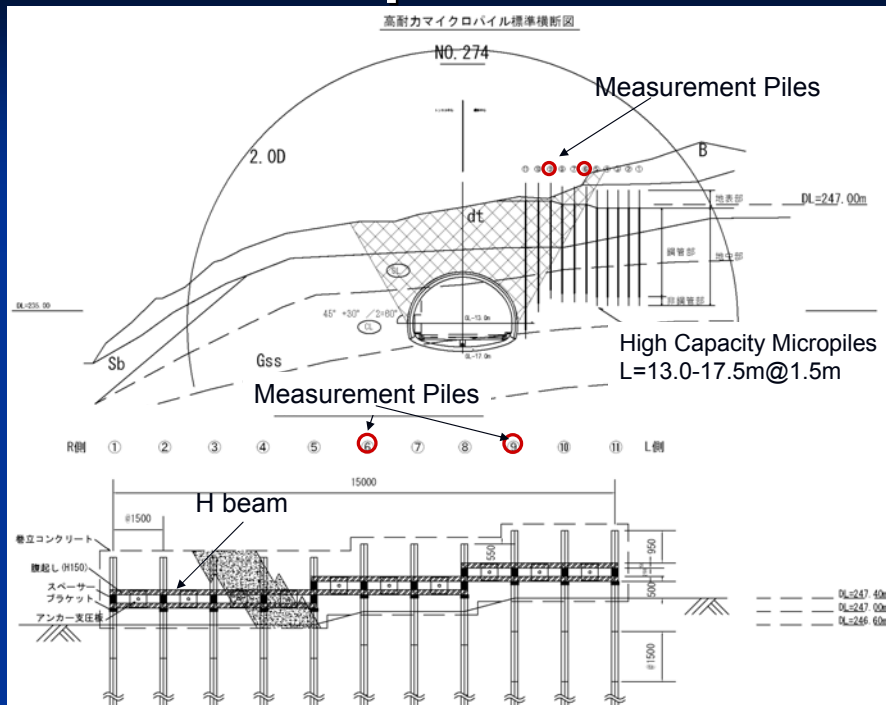
計測杭の概念図です。

高耐力マイクロパイルの場合、鋼管を削孔ケーシングとして用いますので、鋼管へひずみゲージを貼付することは不可能です。

そこで、塩ビ管にひずみゲージを貼付し、鋼管内に設置して計測しました。

ひずみゲージは、想定すべり面(5.6m)および最大曲げモーメントが発生すると予想される深度(2~3m)を考慮して6箇所を設置しました。

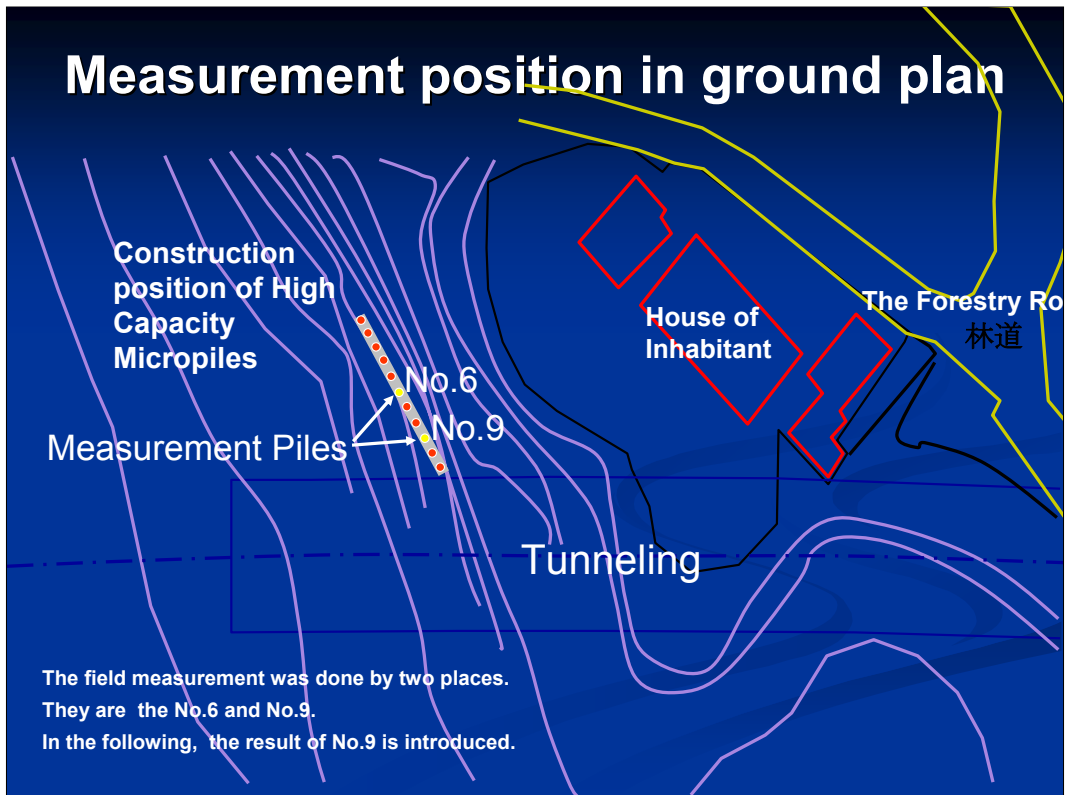
Measurement position in section



予備のライドです。
使用しません。
非表示に設定しています。

計測杭の設置位置の断面図です。

Measurement position in ground plan



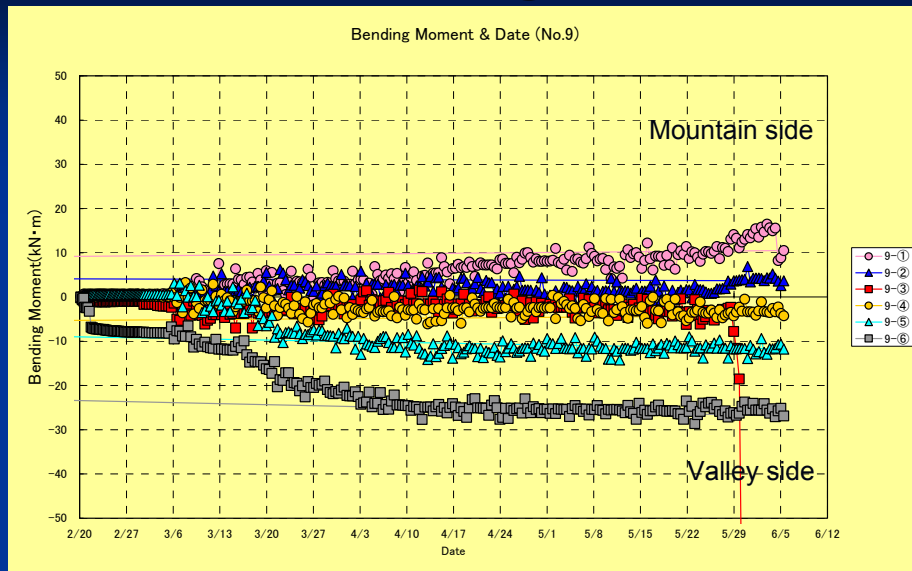
This figure shows the position of the measurement piles.

The field measurement was done by two places.

They are the No.6 and No.9.

In the following, the result of No.9 is introduced.

Date & Bending Moment

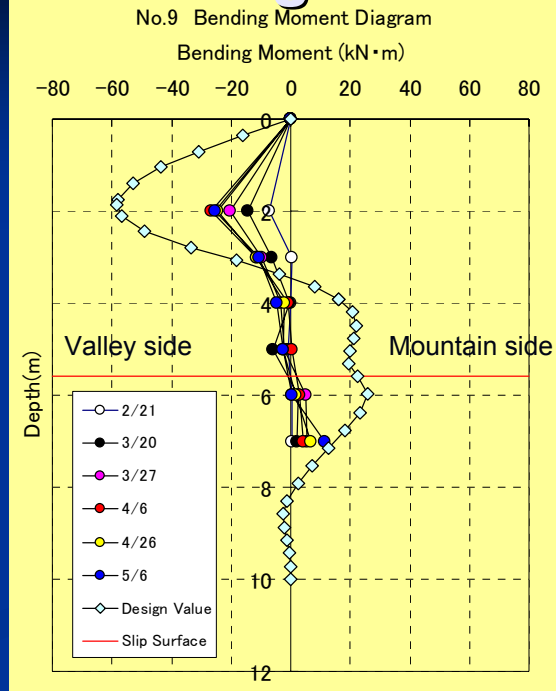


It was March 21 that the tunnel penetrated. The bending moment has increased in those days.
The bending moment changed on March 27. After that, it indicates a constant value.

This figure shows the distribution of the date and the bending moment.
It was March 21 that the tunnel penetrated.
The bending moment has increased in those days.
The bending moment changed on March 27.
After that, it indicates a constant value.

Bending Moment Diagram

- When we had the tunneling, the bending moment was an increasing tendency.
- After the tunnel had penetrated (3/21), the bending moment indicated a value about half of the design.



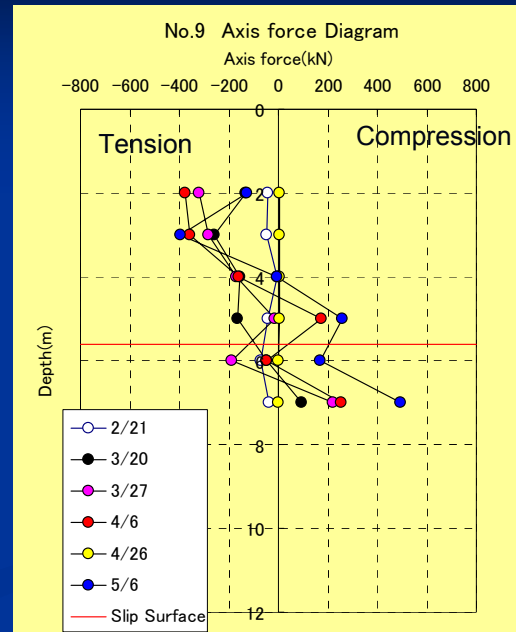
This figure shows depth and the bending moment.

When we had the tunneling, the bending moment was an increasing tendency.

After the tunnel had penetrated (3/21), the bending moment indicated a value about half of the design.

Axis Force Diagram

- The change in the axial force is seen in the sliding surface.
- It might be an influence of the tunneling.
- However, clear consideration is not obtained. We will examine it in the future.




This figure shows depth and the axial force.

The change in the axial force is seen in the sliding surface.

It might be an influence of the tunneling.

However, clear consideration is not obtained. We will examine it in the future.

Conclusion

- The bending moment has increased while digging the tunnel.
 - After the tunnel had penetrated, the bending moment indicated half the value of the design.
- 
- It is thought that High Capacity Micropiles are working as the control piles.

The bending moment has increased while digging the tunnel.

After the tunnel had penetrated, the bending moment indicated half the value of the design.

It is thought that HMP functions as a control works.

トンネルを掘削中の時は、曲げモーメントが増加した。

トンネル貫通後は、曲げモーメントは設計値の半分の値を示した。

HMPは抑止杭として機能していると考えられる。

THE END

Thank you for your attention!!

Thank you.

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