

Numerical analysis to evaluate repair work of swelling-rock damaged tunnels in the mountains using FLAC

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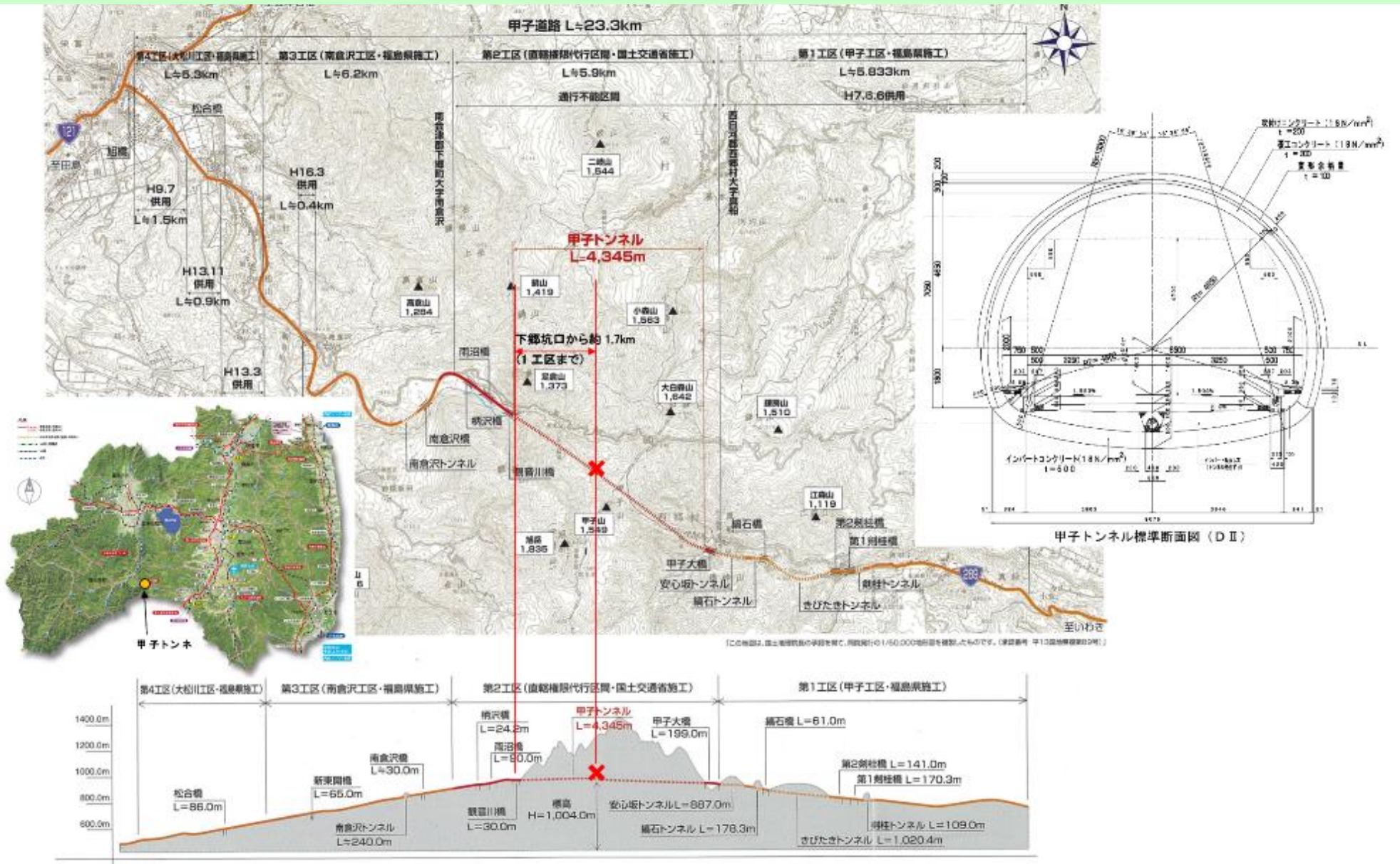
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1. INTRODUCTION



1. INTRODUCTION

Invert concrete about 10 years after construction



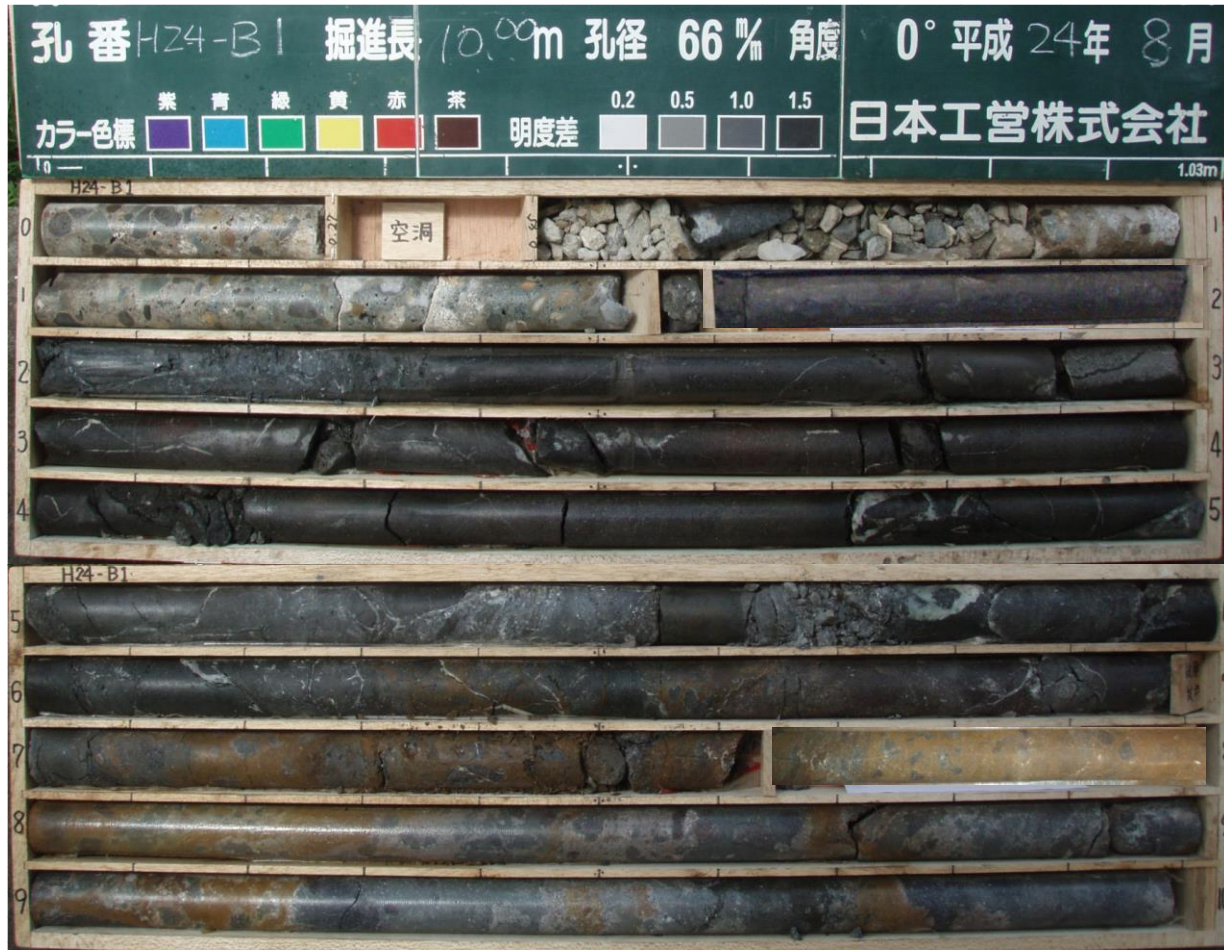
cracks on the entire surface

1. INTRODUCTION

Just collected

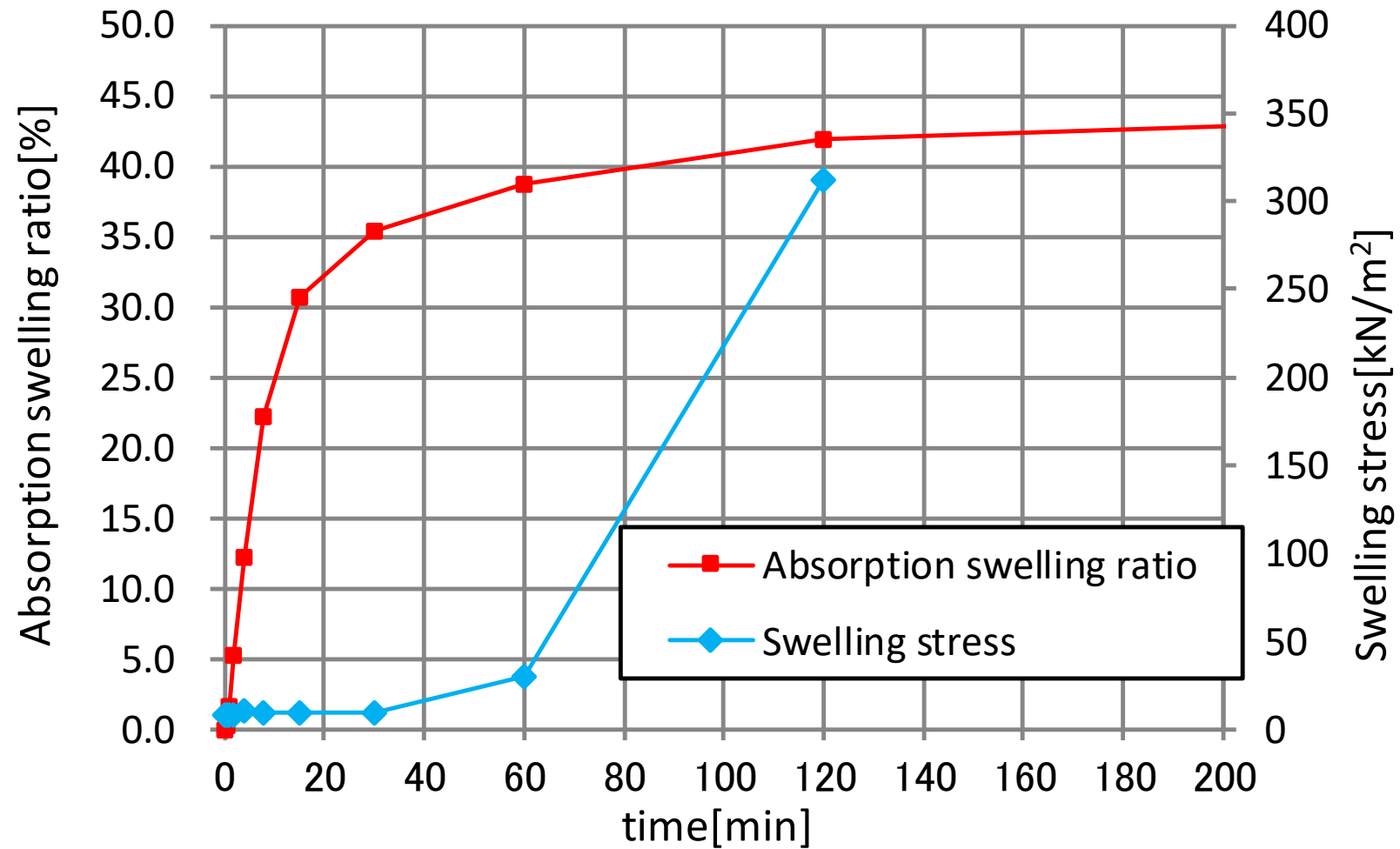


A few days later



The box is broken by swelling

1. INTRODUCTION



before



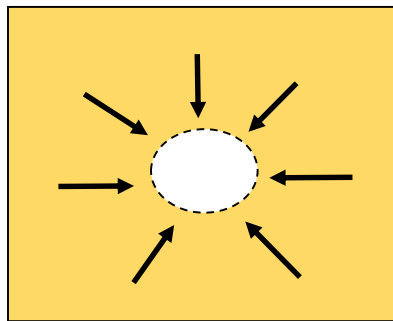
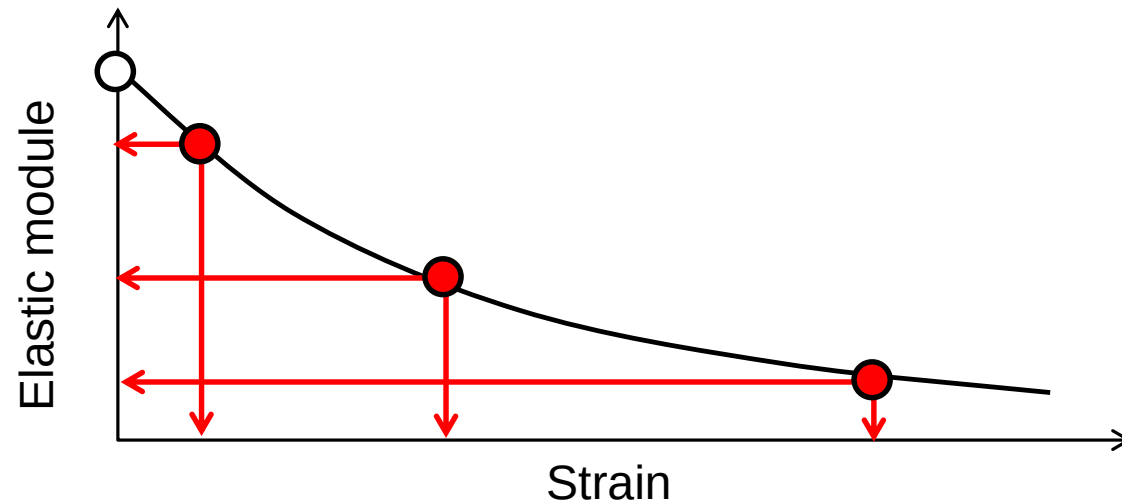
after

Figure 1. The results of swelling test

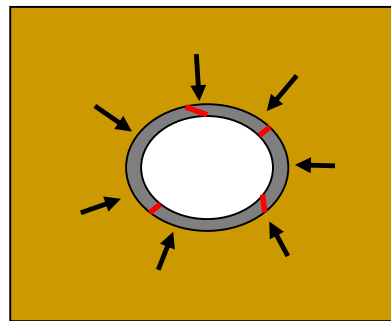
2. SETTING SWELLING MODEL

Model concept

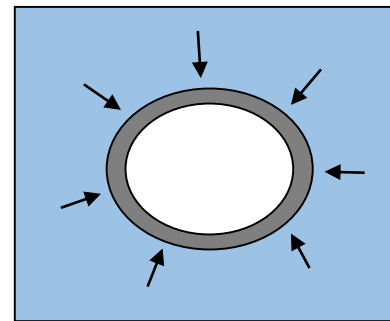
Set “elastic module” according to “strain”



No tunnel support



Tunnel support
with scratch



Tunnel support

2. SETTING SWELLING MODEL

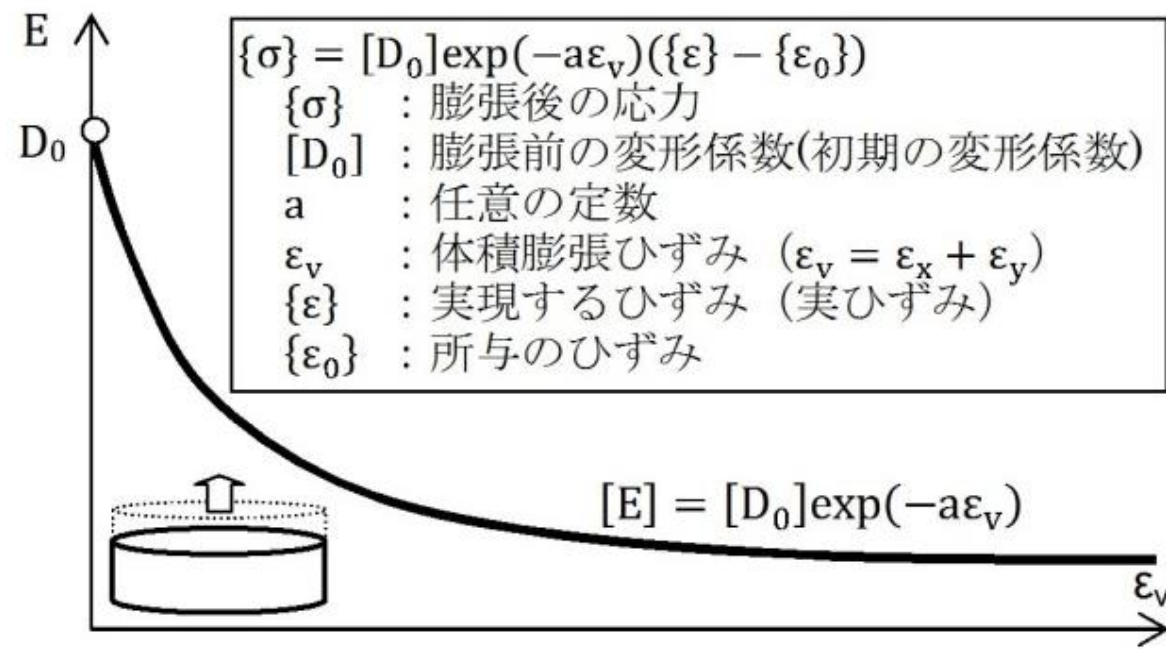
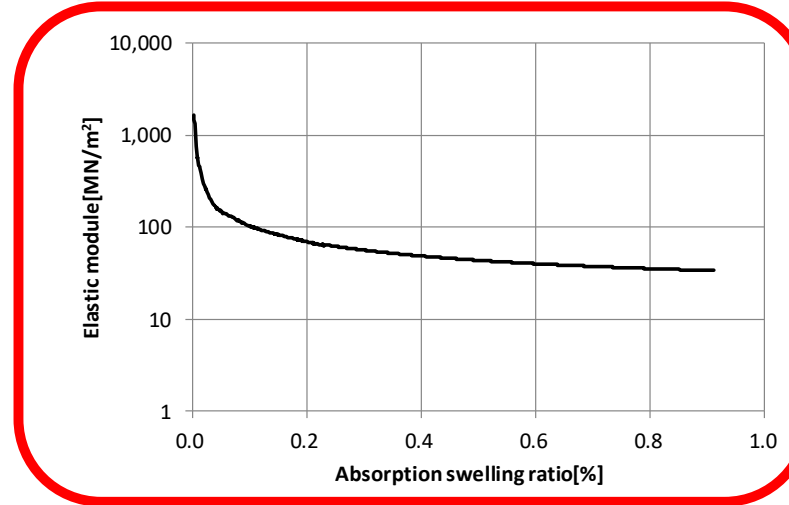
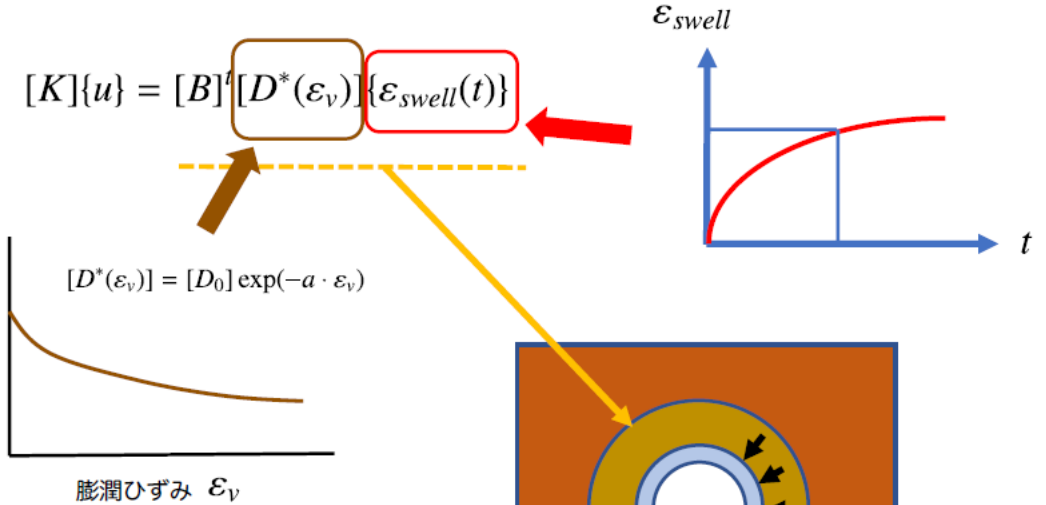
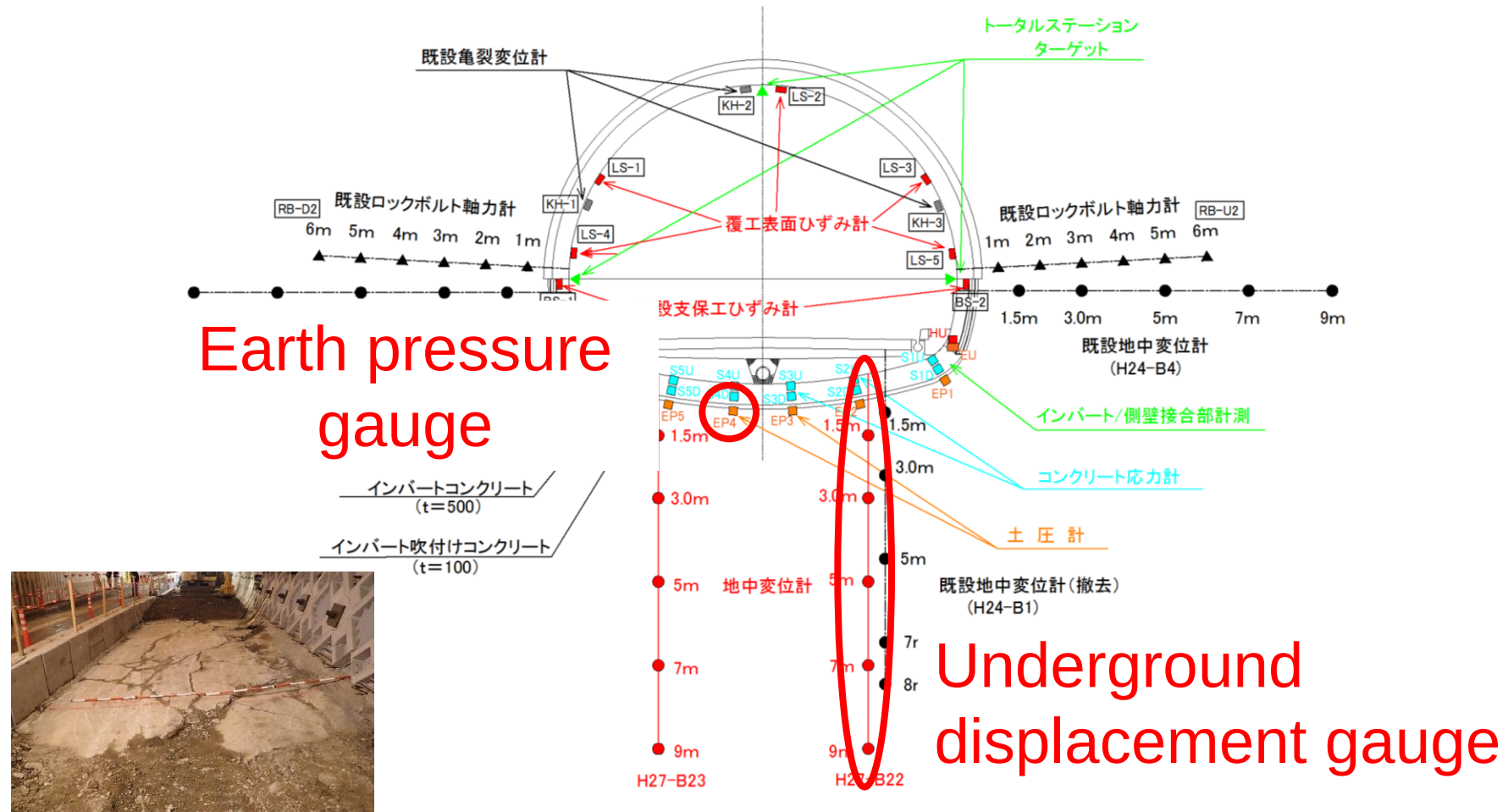


Figure 2. Relationship between the volumetric swelling strain and the elastic module

make these relationships from test results

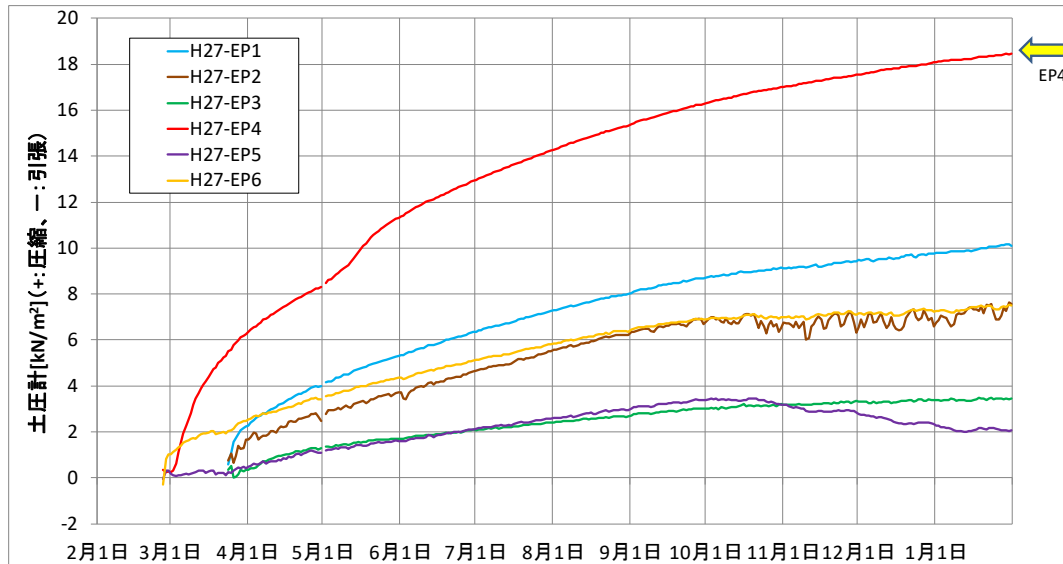


3. PARAMETRIC ANALYSIS

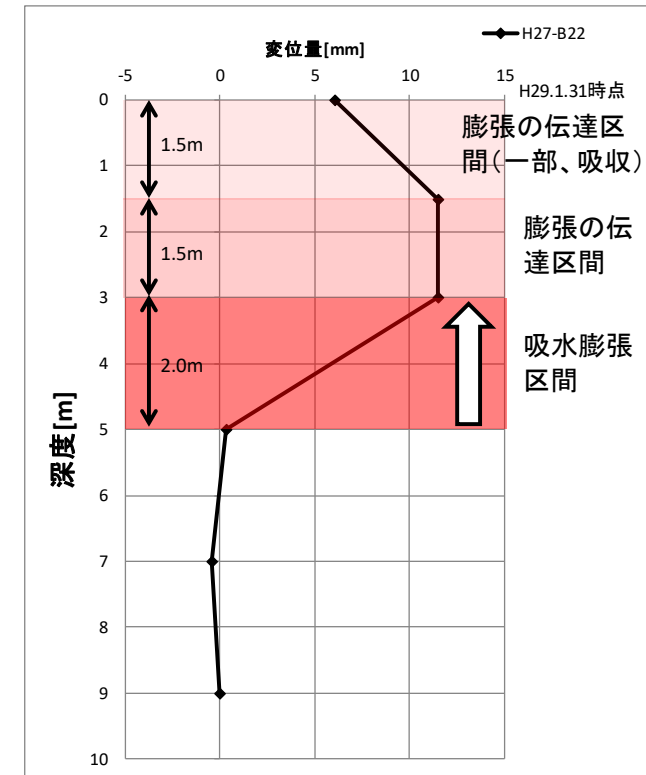
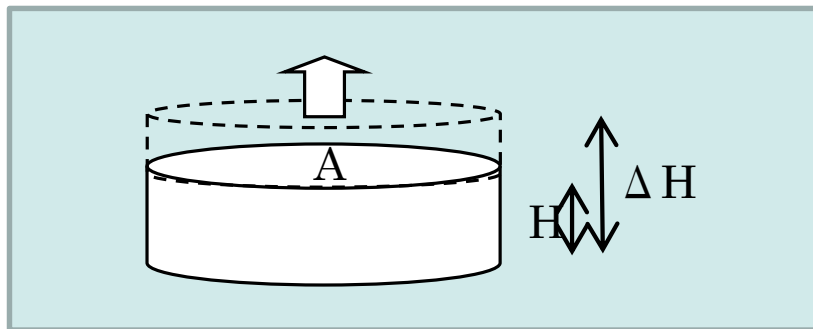


Instruments placed on the measuring cross section

3. PARAMETRIC ANALYSIS



Earth pressure gauge



Underground displacement gauge

3. PARAMETRIC ANALYSIS

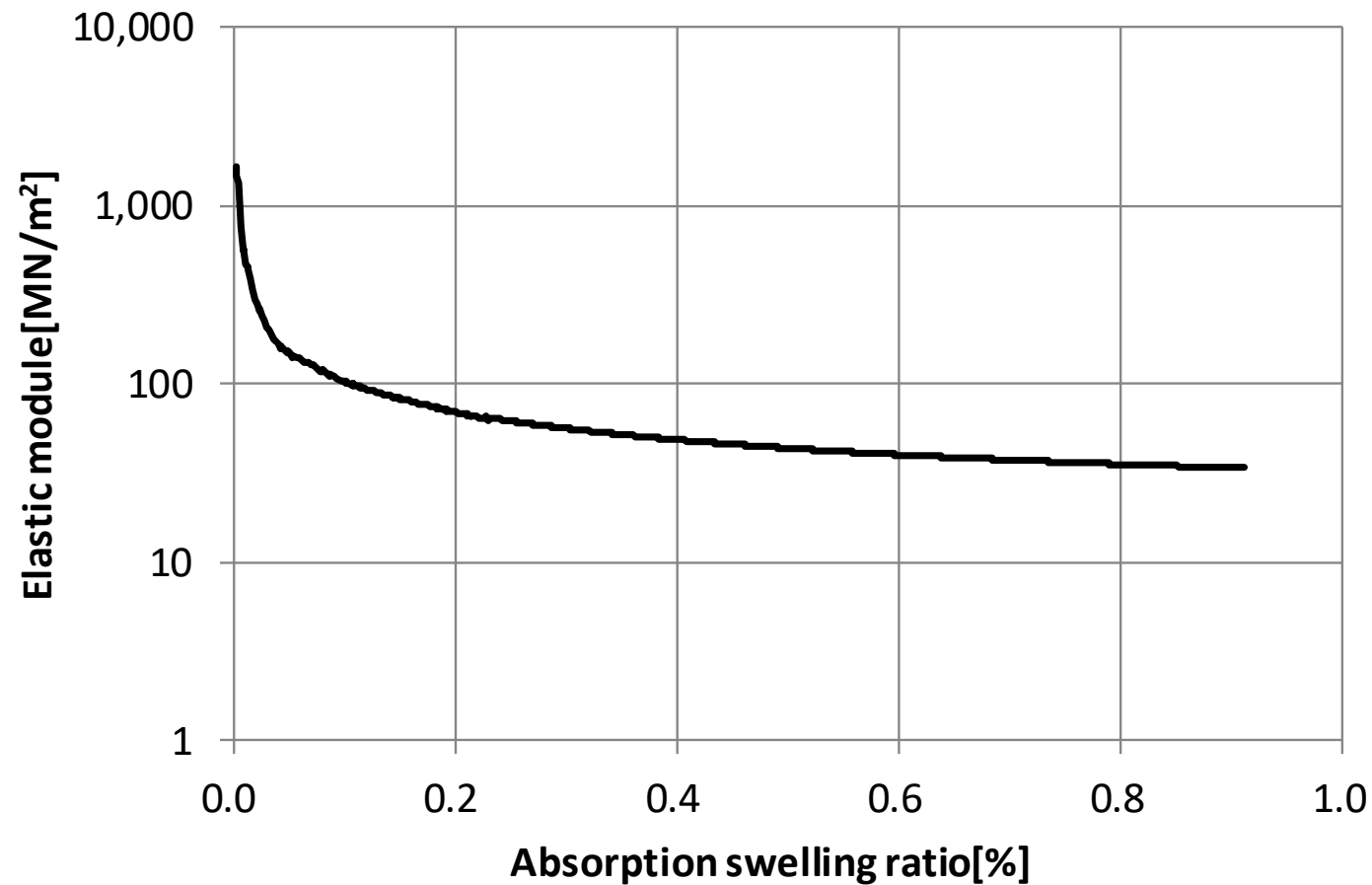


Figure 7 Relationship between the absorption swelling ratio and the elastic module

3. PARAMETRIC ANALYSIS

【 case1 】

the swelling area
was set around
the tunnel

Max displacement:
35mm



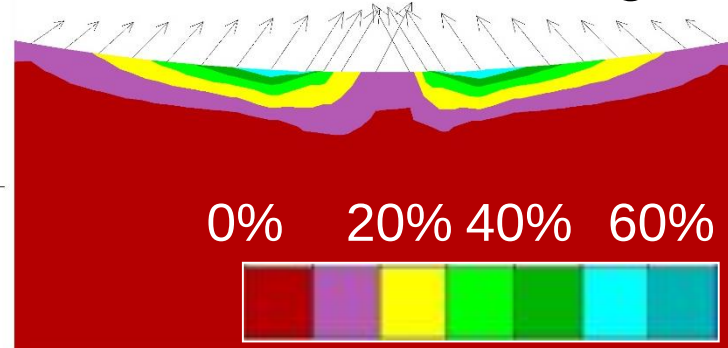
3. PARAMETRIC ANALYSIS

【 case3 】

the swelling area
was set around
the tunnel

Max displacement:
125mm

Distribution of swelling rate



tunnel support included
scratch

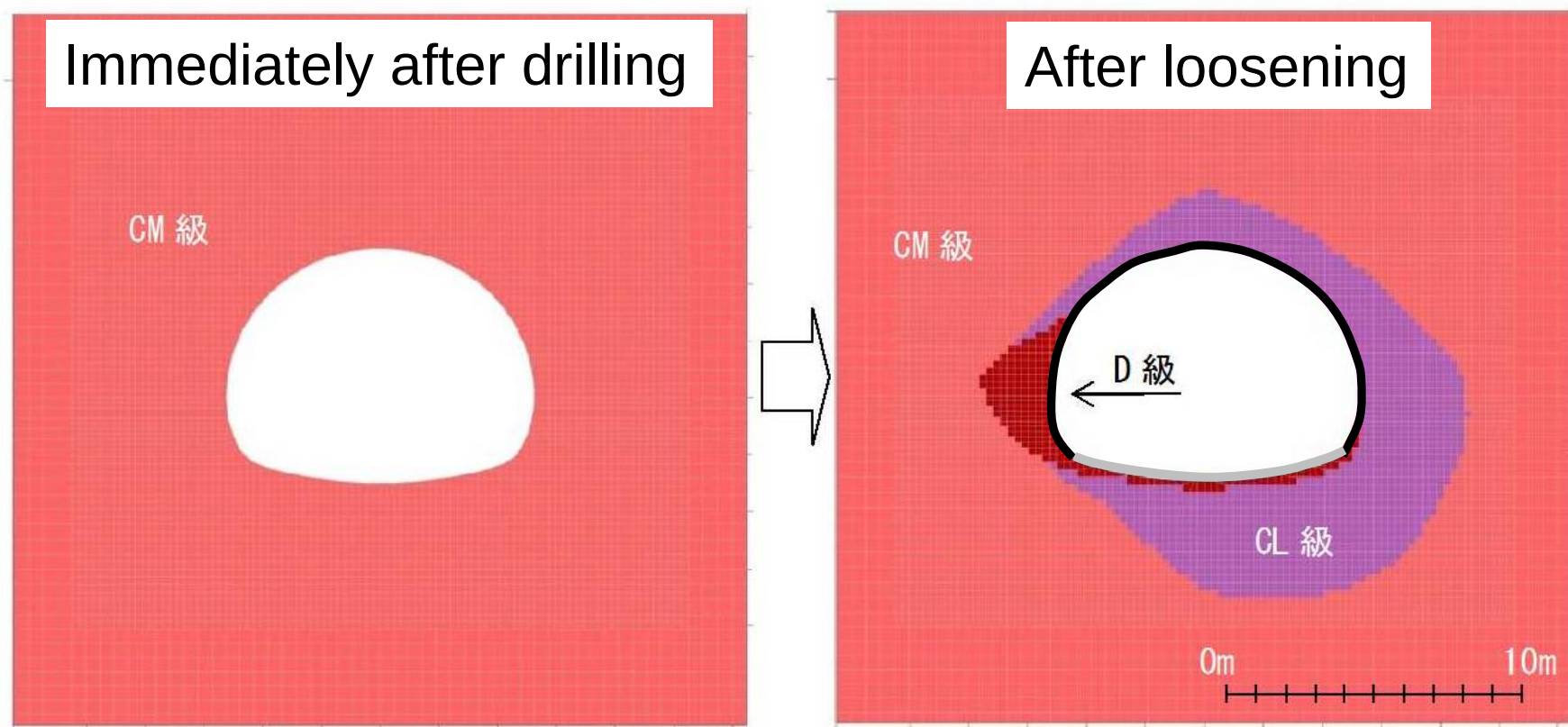
Swelling area

scratch

Tunnel
support

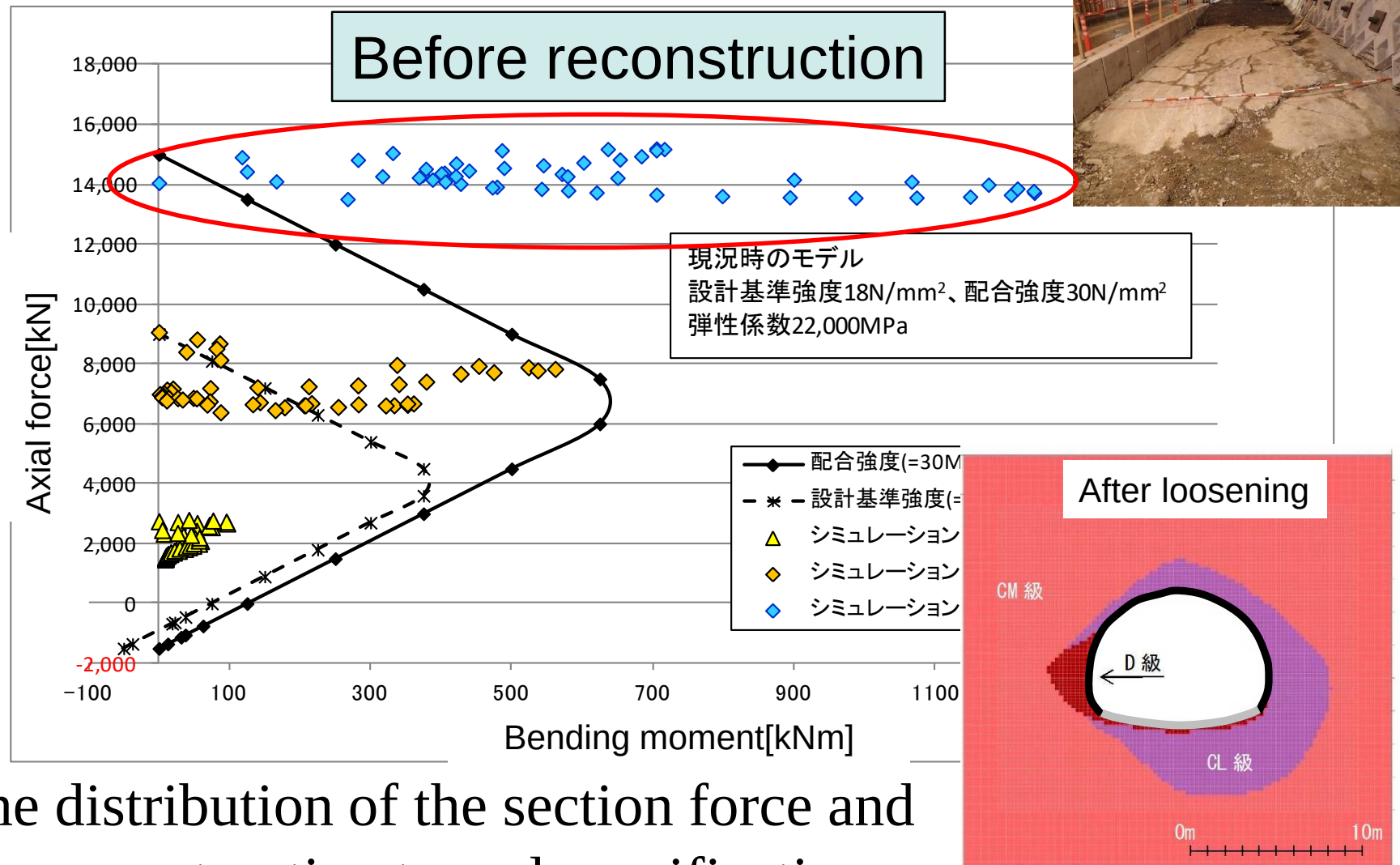


4. APPLICATION TO REPAIR DESIGN



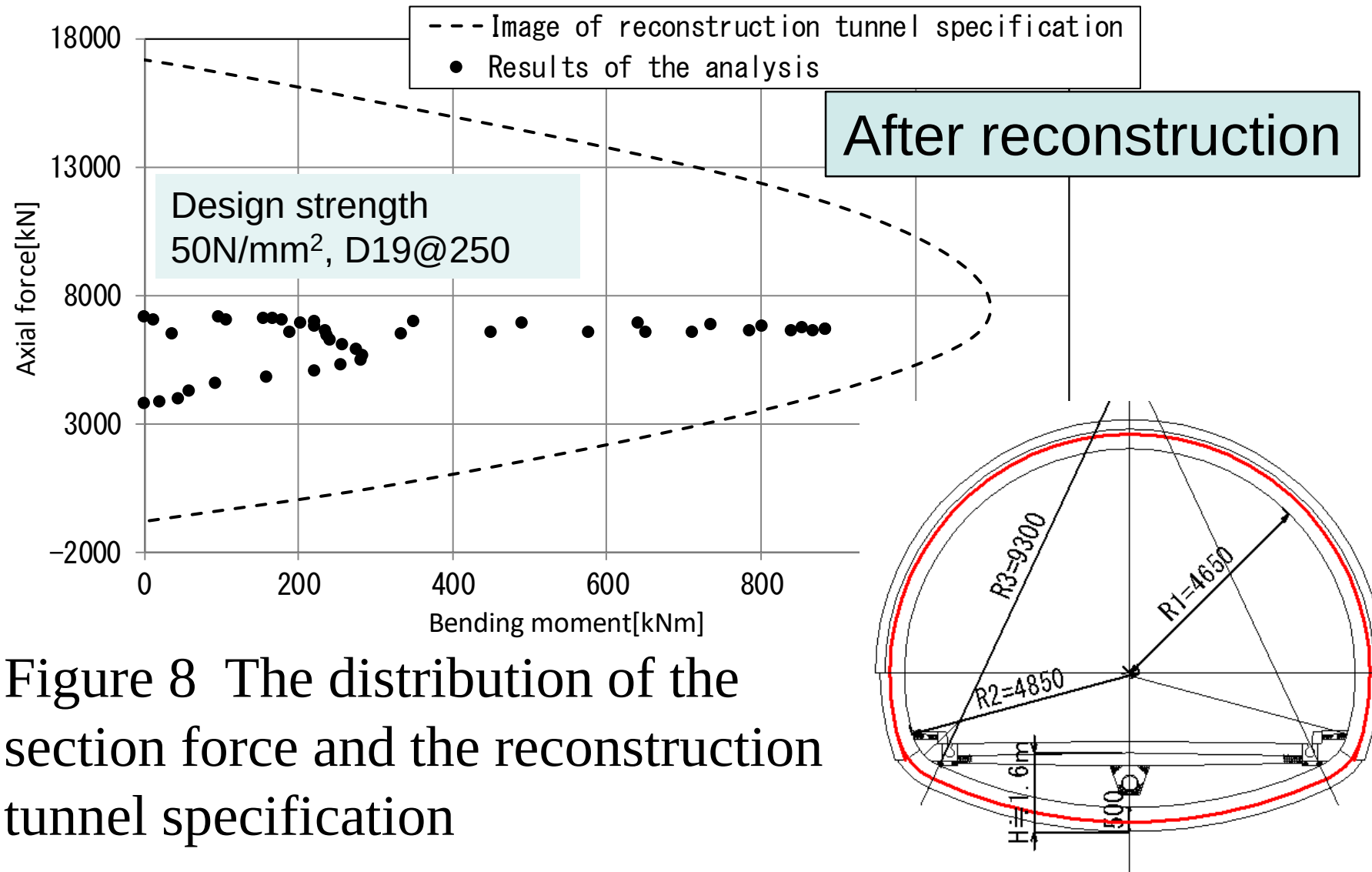
Simulation model

4. APPLICATION TO REPAIR DESIGN



The distribution of the section force and the reconstruction tunnel specification

4. APPLICATION TO REPAIR DESIGN



5. Conclusion

- We developed a numerical simulation model, which considered the interaction between the swelling pressure of the rock and the tunnel structure using the rock deformation due to swelling characteristic of the rock.
- By applying the model to the actual tunnel and examining the characteristics of the model, this model was consistent with the general mechanism that the swelling pressure.
- In addition, we examined the reconstruction design of the mountain tunnel under service. As a result, we decided on the repair design that included the distribution of section force obtained by analysis.