Progression of Deterioration in Cement Treated Soil

セメント改良土の水浸による強度低下

The progression of deterioration in cement treated surplus soils under ground water was investigated by conducting mechanical and chemical testing periodically. Deterioration was identified in two stages; primary deterioration (0-25 days) and secondary deterioration. Primary deterioration appeared due to moving of soluble ions from pore solution before creating hydration products. Secondary deterioration was found as a result of leaching of ettringite. In addition to that it was found that secondary deterioration depth show a linear relationship with squared root of soaking time.

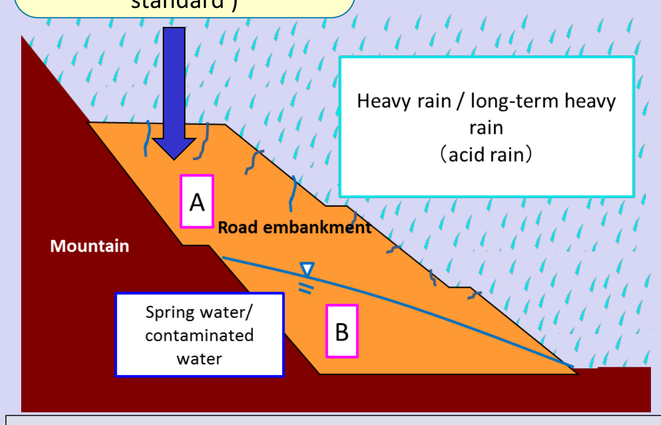
低改良率セメント改良土の水浸による強度低下について検討した。強度低下は水浸後1か月程度までに起こる一次劣化、その後徐々に起こる二次劣化の2段階で確認された。 一次劣化は、水和生成物が生成される前に間隙水から可溶性イオンが移動するため、二次劣化はエトリンガイトの浸出が原因であると考えられる。また、二次劣化深さの二乗と浸漬時間は線形関係を示した 。

(1) Introduction

Low-quality construction generated soils

+

Cement 3.5 %
(equal to 50kg/m³ minimum amount recommended in standard)



Simulation of curing conditions in laboratory

Case A
Sealed condition

Constant temperature

Saturated 1 day before testing

plastic sheet

Case B
Soaked condition

Constant temperature

(a)Acidic water (pH= 4.5)

$H_2SO4 : HNO_3 : HCl$= 5 : 2 : 3
Volume ratio between specimen and soaking water 1:5

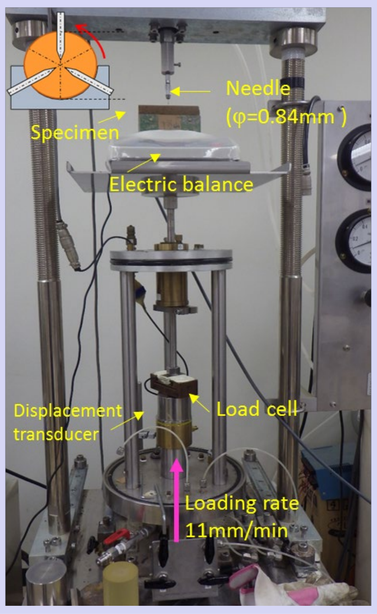
Materials and testing method

Soil classification (JGS 0051)	SF sandy soil
Soil particle density, ρ_s (g/cm³)	2.693
Optimum water content, w_{opt} (%)	21.6
Maximum dry density, ρ_{dmax} (g/cm³)	1.62
Cone index , qc (kN/m²)	68
Sand (%)	52.9
Silt (%)	21.6
Clay (%)	24.7

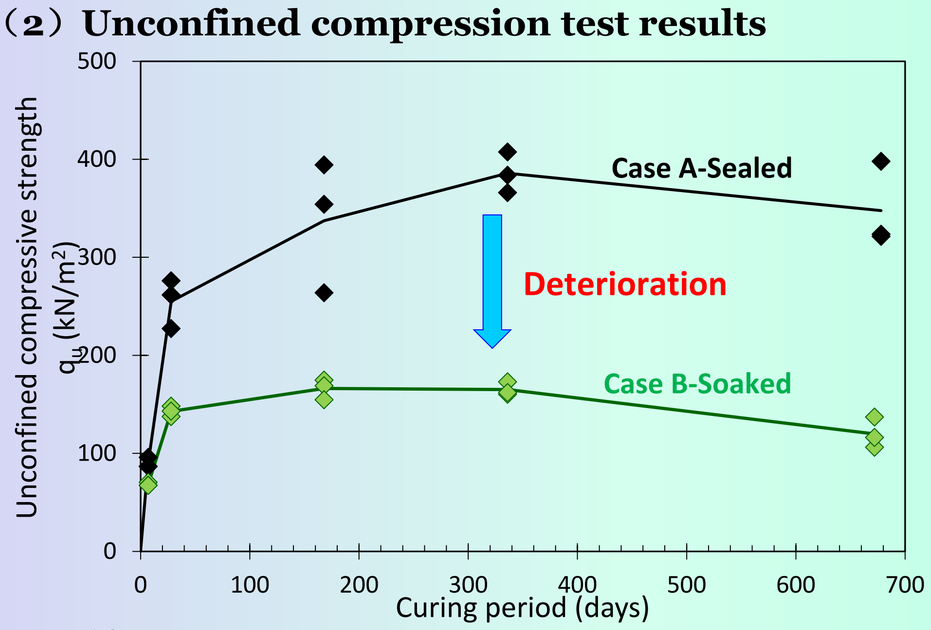
✓Unconfined compression test
✓Needle penetration test

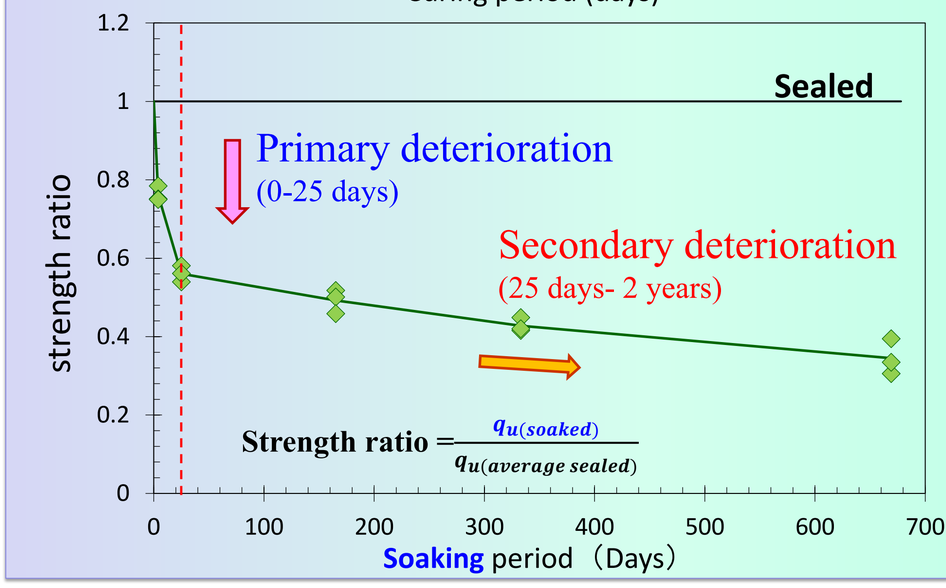
Specimen condition

- Diameter 50 mm, Height 100 mm
- Degree of compaction, Dc= 90 %
- Soaking start after 3 days of preparation
- Soaking water exchanged periodically

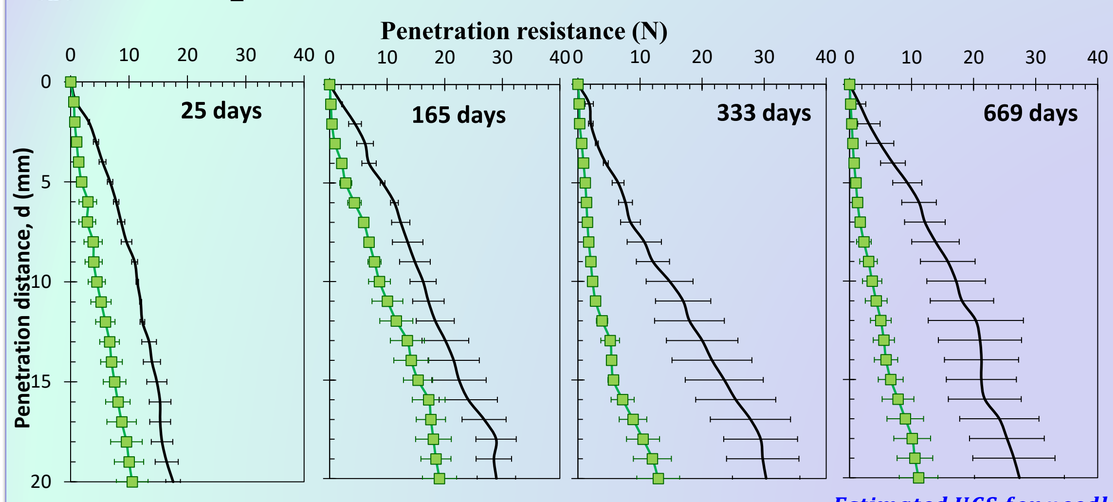


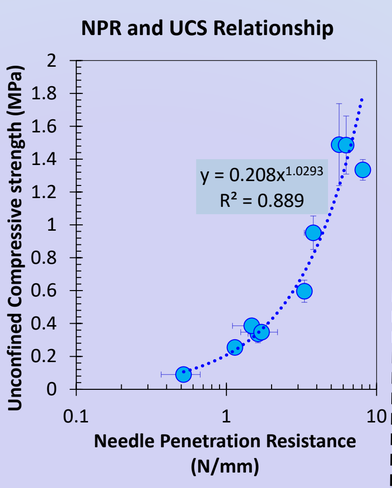
(2) Unconfined compression test results





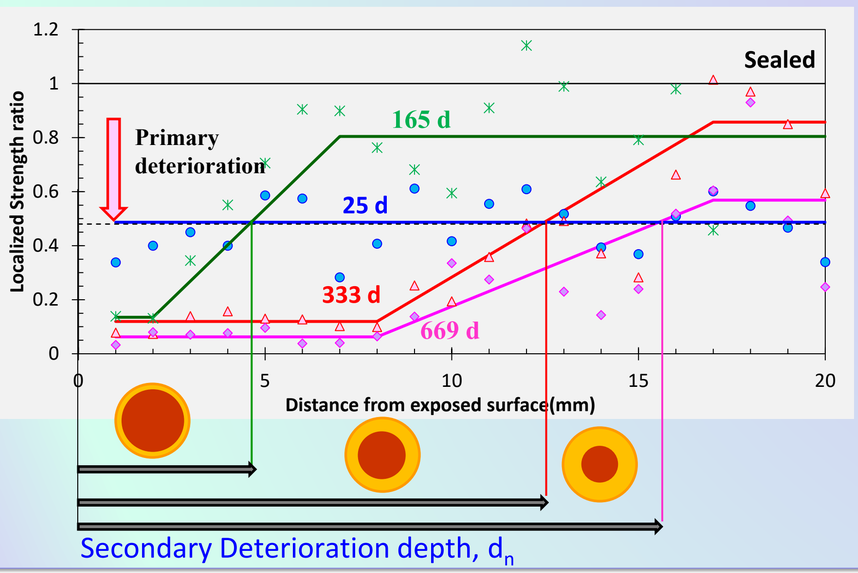
(3) Needle penetration Test results



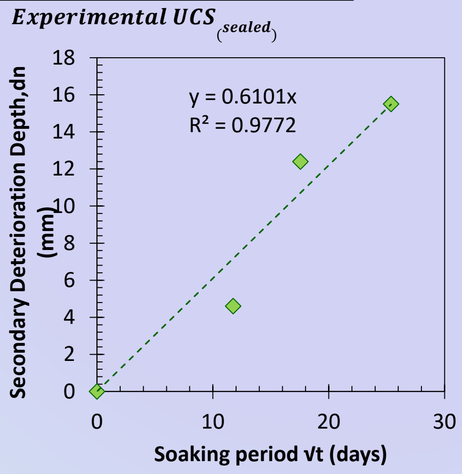


Estimated UCS for needle test

$$\text{Localized Strength ratio} = \frac{\textit{Estimated UCS for needle test}_{(soaked)}}{\textit{Experimental UCS}_{(sealed)}}$$



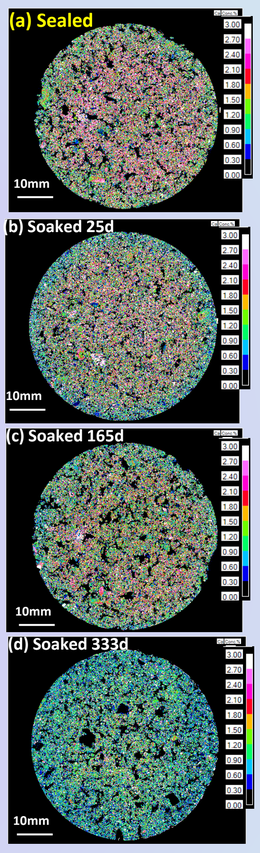
Secondary Deterioration depth, d_n

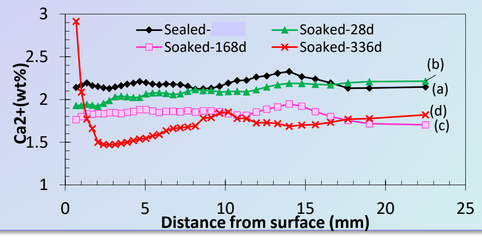


$$d_n = A\sqrt{t}$$

Secondary Deterioration coefficient

Electron probe micro analyser (EPMA)



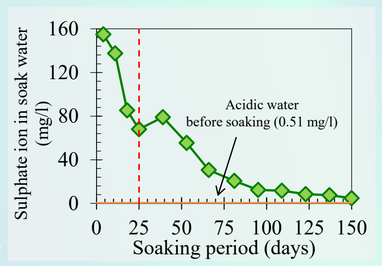


(4) Mechanism of deterioration

1. Primary deterioration (0-25 days)

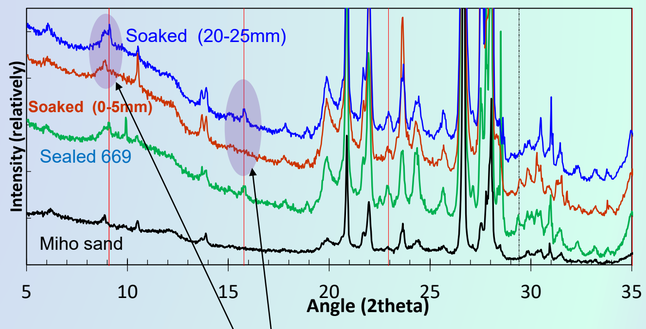
Moving of ions which required for proper hydration reaction, to water from pore solution (before creating solid hydration products)

Barbara et al 2006



2. Secondary deterioration

X-ray diffractometer analysis (XRD)



Ettringite leached out from the surface of the soaked specimen

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