Binders for stabilisation

- **Quicklime** can regarded as a basic binder for soil stabilisation. In 70´s when deep stabilisation method was developed, method was called Lime Column method

- In 80´s mixture 1:1 of **lime** and **cement** came most popular binder in stabilisation in Nordic countries. Lime cement mixture is effective combination of two reactive material
  - CaO → heat accelerate reactions, diffusion effect, long term hardening
  - cement → hydraulic, fast hardening

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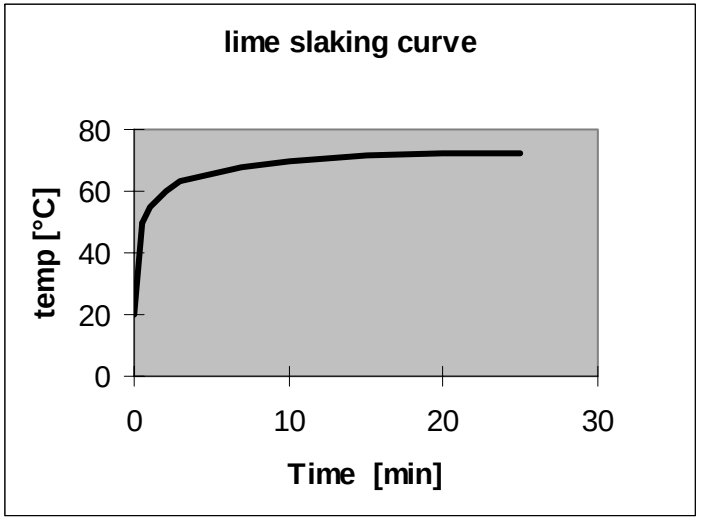
Instant reactions of quick lime

Slaking

- $CaO + H_2O \rightarrow Ca(OH)_2$
  - 100 g quicklime binds 32 g water
  - Released energy (1163 kJ/kg)

  → water evaporates



Ion exchange reactions

Ca^{++} / Na^+, K^+, Mg^+, H^+

clay structure turn coarser

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Long term reactions of lime

Pozzolanic reactions

- pH rises up to 12 → crystal structure of clay brakes → release silicon (Si) and aluminium (Al) for reactions with calcium

- end products are similar than in hydration of cement (CASH, CSH) → clay structure changes permanently

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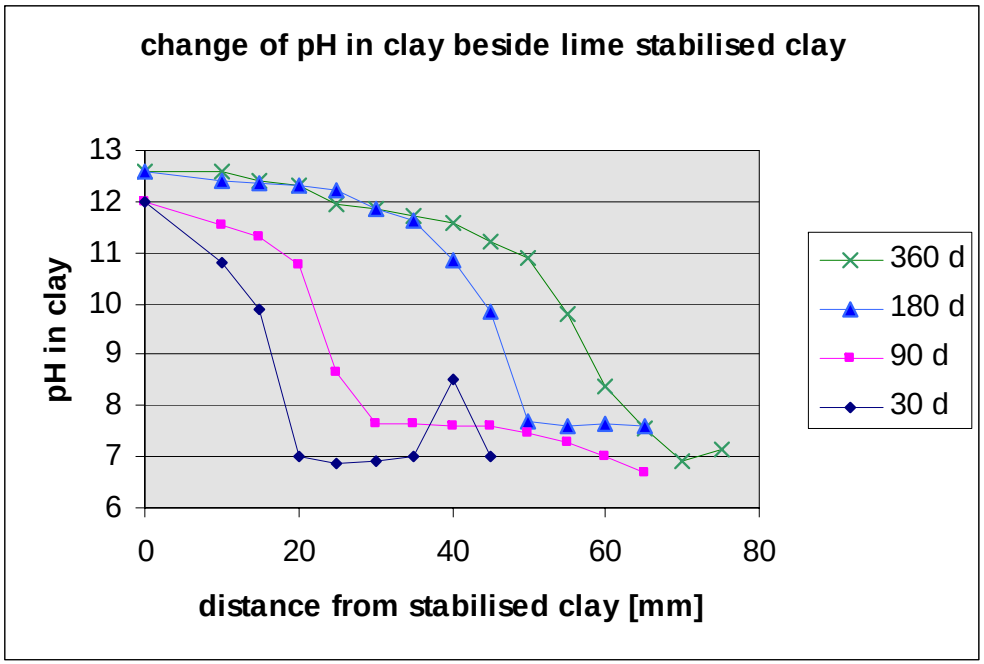
Diffusion phenomenon of lime

Lime has specially ability to compensate insufficient mixing work: Ca^{2+} ions moves to lower ion concentration in unstabilised clay. That leads to more homogeneous structure and better contact with stabilised/unstabilised clay.
Diffusion effect can measure by change of pH in unstabilised clay.



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Reactions of other binder compounds

- Cement → hydraulic, reaction products CSH, CASH etc. clues soil particles together
- Gypsum → reaction product *ettringite* get strength rapidly
- LKD → CaO as active component
- Blast furnace slag → latent hydraulic, alkali activation with $Ca(OH)_2$ will get similar reaction products than cement
- Fly ashes → usually needs alkali activation, pozzolanic, i.e. reacts with $Ca(OH)_2$

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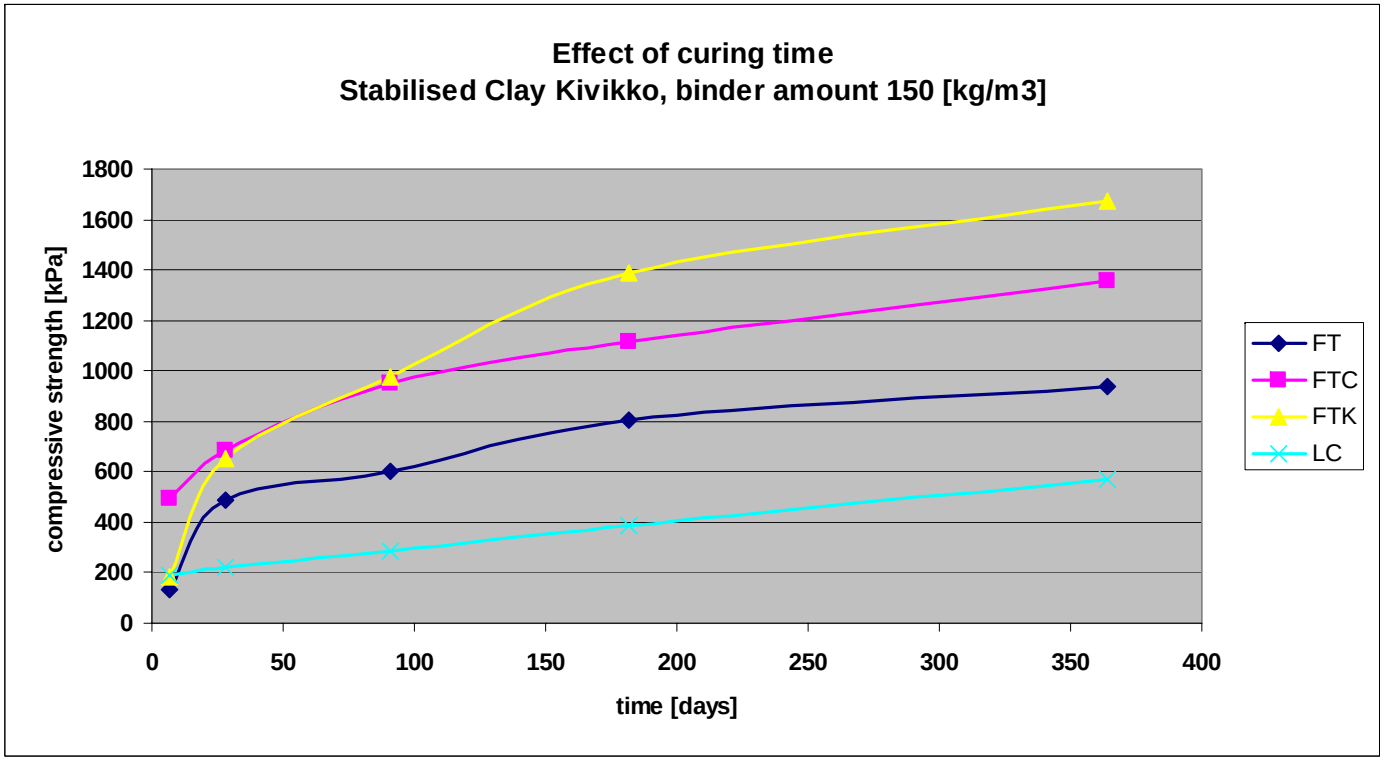
Long-term strength

- Lime based binders have good capability to get more strength in time. There is measured even six fold strength after six years compared to typically 1 month strength value in situ.



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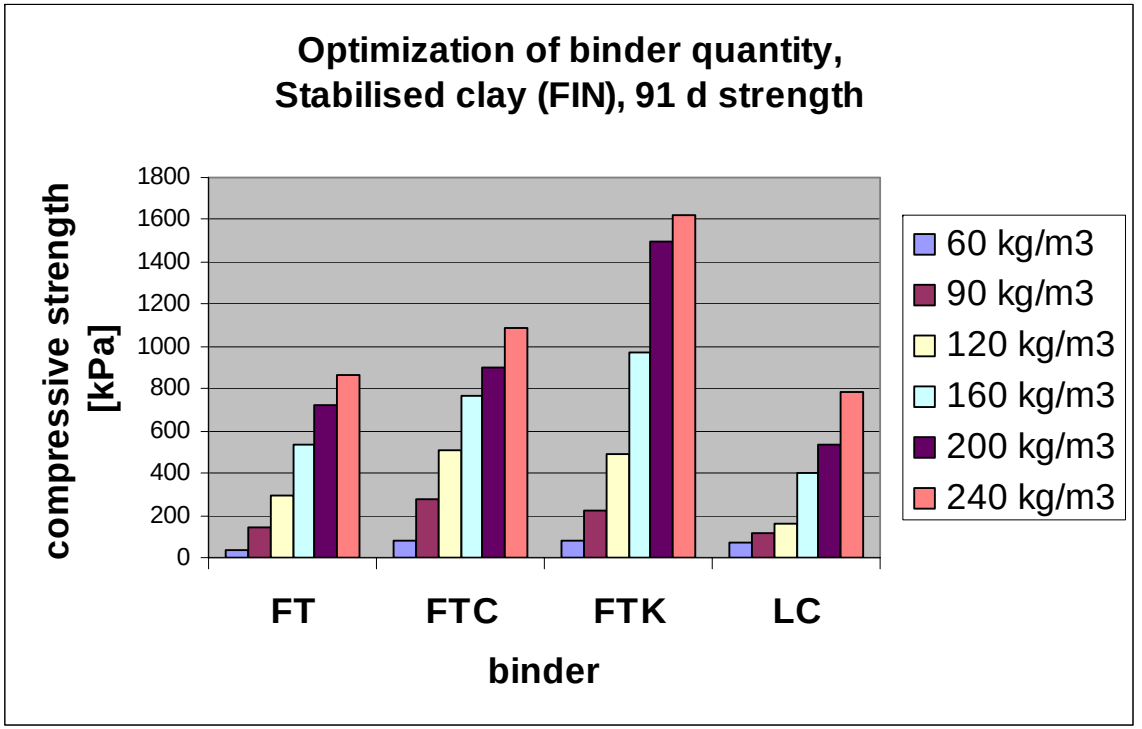
Effect of binder amount

- Stabilisation of clay, gyttja and peat is controllable by choosing proper binder and sufficient binder amount
- Different soil types have often critical binder amount. After that critical value strength rises remarkable



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Effect of soil characteristic

Clays, gyttjas and peat are very complicated soil types. There is lots of different variations that affect to stabilisation reactions:

- water content, w
- granulation, clay content i.e. – 2 μm fraction
- humus content
- sulphur content, form of sulphur (sulphide, sulphate etc.)
- plasticity, sensitivity
- reactive compounds (soluble/amorphous Si, Al)
- cation exchange capacity

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Nordkalk Terra™ binders

Finland

• Nordkalk Terra ™ KC50 and KC30	lime + cement
• Nordkalk Terra ™ GTC	lime + gypsum + cement
• Nordkalk Terra ™ POZ	lime + cement + LKD

Sweden

• Nordkalk Terra ™ KC50	lime + cement
• Nordkalk Terra ™ 80	quicklime
• Nordkalk Terra ™ E	fly ash
• Nordkalk Terra ™ KCE	lime + cement + fly ash

Estonia & Russia

- Nordkalk QL products

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