Lime Treatment of Soils
The Friant-Kern Canal experience

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Friant-Kern Irrigation canal

- Built in 1946, 240 km long
- Canal discharge rate: 100 m³/s
- Speed of 1.3 m/s
Earth and concrete-lined blankets

- 87 km of the canal built with Porterville clays (montmorillonitic clayey soil)
- Below water level: volumic expansion, lowering density and strength
- Above water: shrinkage, cracks, loss of shear strength and slidings

![Diagram of canal construction with before and after images.](image)
Decisions of US Bureau of reclamation for renovation

- Problem of availability of suitable soils for replacement of failed soils
- Replacement by rock or gravel not satisfactory
- 70’s : Decision for lime treatment for restoration of damaged zones
- Purpose : stabilize slopes only
♦ First operations : 1972
  ● Lime dosage according lab study :
    4 % granular quicklime (CaO)
  ● PI reduction : 47 to 12
  ● Shrinkage limit increase : from 7 to 26 %
  ● Increase of compressive strength x20

♦ Construction procedure
  ● Moving the failed material from the banks
  ● Partial lime treatment of sticky soil to facilitate excavation
  ● Material moved to the canal bottom for lime spreading and mixing steps
  ● Mellowing overnight before placement
Placement and compaction

- 30 to 40 cm lifts on the banks
- Compaction with a vibrating sheepfoot roller, « yo-yo » fashion

Next projects (1975-77 and 1983-84): changes

- Placement of the lime-treated material in horizontal lifts, « stair-step » construction
- Bank slope trimmed
- Mixing step in adjacent areas (flexibility of the solution)
Feedback and performance of lime-treated sections

- After 1 year irrigation: sheepfoot rollers imprints still visible
- No new slips or slides since the renovation works
- Rc on cored specimens: 2.2 MPa (after 1 month) to 3.4 MPa (after 1 year)
Testimonials

- Lime treatment induces **no need for additional material**, flattening of slopes…
- After 1 year service, unprotected lime-treated lining did not suffer from **erosion**
- Gravel belt judged unnecessary (60 000 $ **cost savings**)
- Lime-treated sections, initially to be recovered with concrete panels, stayed unprotected without erosion or unstability
- Lime stabilized linings needs the **less maintenance**
- No measurements of other properties (permeability), but indirect signs of waterthightening
**Other testimonials of lime applications**

- Mississippi River Levees
- Earth dams
- Case of dispersive soils
- French structures, to be investigated

<table>
<thead>
<tr>
<th>Country</th>
<th>Amount of hydrated lime</th>
<th>Type of test</th>
<th>Curing</th>
<th>Problem</th>
<th>Structure type and location where treated soils placed</th>
<th>Remarks</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>New South Wales, Australia</td>
<td>0.5%</td>
<td>Small scale dam model investigation</td>
<td>Not provided</td>
<td>Tunneling failure due to dispersion</td>
<td>Upstream face of the embankment</td>
<td>Recommended to compact the soil to 80% of max. dry density</td>
<td>Rosewell 1977</td>
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<tr>
<td>Canada</td>
<td>1%</td>
<td>Pinhole test</td>
<td>Not provided</td>
<td>Erosion of sensitive marine clay</td>
<td>Dyke’s foundation</td>
<td>Reported that lime acted as cementing agent</td>
<td>Dascal and Hurtubise 1977</td>
</tr>
<tr>
<td>New Mexico</td>
<td>4%</td>
<td>Pinhole test</td>
<td>Minimum of 4-day curing</td>
<td>Internal erosion of dispersive soils</td>
<td>Fractured sandstone foundation of Los Esteros dam</td>
<td>Recommended to cure soil-lime mix in loose state at near OMC before the placement and compaction</td>
<td>McDaniel and Decker 1979</td>
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<tr>
<td>Mississippi, USA</td>
<td>2-3%</td>
<td>Laboratory dispersion test</td>
<td>Minimum of 2-day curing</td>
<td>Surface erosion</td>
<td>Slopes of dams</td>
<td>Recommended to cure soil-lime mix in loose state before the compaction</td>
<td>Perry 1977</td>
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</tbody>
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Thank you for your attention!

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