Comparison of Geotechnical Beam Centrifuge Predictions to Field data from 10m FFT Centrifuge Cake Columns

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The Message

Beam centrifuge provided a good approximation of the field performance of 10m deep FFT centrifuge cake columns.
Content

- Beam centrifuge tests (Modeling of Model test)
- 10m FFT centrifuge cake columns
- Comparison of Physical Model Vs Field Data
- Concluding Remarks
Beam Centrifuge Models

- 3 Models to simulate prototype
- 12m initial height of prototype
- Varied model heights, g levels and flight times

<table>
<thead>
<tr>
<th>Test Code</th>
<th>Sample Description</th>
<th>g level</th>
<th>Height</th>
<th>Flight time (hour)</th>
<th>Prototype time (years)</th>
</tr>
</thead>
<tbody>
<tr>
<td>SC-MM-1</td>
<td>Gypsum-treated centrifuge cake</td>
<td>120</td>
<td>10 (cm)</td>
<td>84</td>
<td>138</td>
</tr>
<tr>
<td>SC-MM-2</td>
<td>Gypsum-treated centrifuge cake</td>
<td>100</td>
<td>12 (cm)</td>
<td>120</td>
<td>137</td>
</tr>
<tr>
<td>SC-MM-3</td>
<td>Gypsum-treated centrifuge cake</td>
<td>80</td>
<td>15 (cm)</td>
<td>192</td>
<td>140</td>
</tr>
</tbody>
</table>
10m FFT Centrifuge Cake Columns
Objectives

- Understand consolidation of FFT centrifuge cake
- Assess consolidation impacts of
  - Coke capping
  - Under-drainage
  - Wick drain
Cake Column Configuration

- 11m high, 3m diameter
- Low friction internal wall
- Top extendable, for cap placement
- Instrumented
  - Pore pressure
  - Settlement
  - Temperature
  - Total stress
  - Met data
  - Standpipe
Cake Deposition
Modeling of the Models Test

Taylor (1995) and Ko (1988)
Modeling of the Models Test

[Graph showing the relationship between Final Model Height (cm) and 1/N X 10^2 for Models 1, 2, and 3.]
Results

Comparison of Deformation Data
Column 6 (Dry Cap + under-drainage)

- Agreement only for the first 20 days
- Divergence due to under-drainage, drying, thaw strain
- Coke capping also enhanced deformation of field columns
Column 5 (Dry cap, Under-drainage, wick drains)

- Agreement only for the first 20 days
- Divergence due to under-drainage, wicks, drying, thaw strain
- Coke capping also enhanced deformation of field columns
Agreement for the first ~50 days

- Divergence due to wicks, drying, thaw strain
- Coke capping also enhanced deformation of field columns
Column 3 (Wet Cap)

- Agreement for the first ~50 days
- Divergence due to drying, thaw strain
- Coke capping also enhanced deformation of field columns
Column 2 (Dry Cap)

- Agreement for the first ~60 days
- Divergence due to drying, thaw strain
- Coke capping also enhanced deformation of field columns
- Closest agreement between field data and beam centrifuge
- First ~200 days, very good match
- Slight divergence afterwards due to drying and thaw strain
Comparison of Pore Pressure Data
Except at base, similar profiles of initial excess pore pressure
Beam centrifuge approximates the initial stress conditions of field cake columns
Column 6 (Dry Cap + Under-drainage)

- Agreement for year 1, except close to the base
- Divergence afterwards due to response to coke capping
- Closest agreement between field data and beam centrifuge
- Compared to centrifuge models, faster rate of excess pore pressure dissipation, consistent with deformation pattern
Significance of Findings

- Physical modeling a viable alternative (complement) to numerical modeling
- Physical modeling could be an alternative to field prototyping
- Can expedite decision making for tailings management and reclamation planning
Conclusions

- Scaling laws was validated for centrifuge cake (*literature first*)
- Beam centrifuge simulate the stress conditions of field cake columns
- Beam centrifuge models self-weight consolidation field performance of centrifuge cake (*literature first*)
Credits

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- Drs David Carrier and Ed McRoberts
- Jon Spence and Geoff Halferdahl (Syncrude Canada)
- Yazhao Wang (University of Alberta)
Thank you