Geotechnical characterization of a frozen and thawed centrifuge cake

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Canada’s Oil Sands
Athabascaca Region, Alberta

Surface mining practice

Overburden

Haul to treatment plant

Typical Oil Sands Ore body

Inter-bedded clay-shale and oil-sands formation
Extraction of Bitumen and Production of Oil Sand Tailings

1 barrel of oil = ~1 m³ of sand + ~0.25 m³ of FFT
+ (0.8 m³ river + 1.74 m³ recycle) water + 0.5 to 1 m³ overburden

About one billion m³ of FFT
Dewatering the FFT using various processes

- Thickening: TT
- Centrifugation: Centrifuge cake

Shrinkage Limit Range
Plastic Limit Range
Liquid Limit Range
Soft Deposit Capping 1 – 2 kPa
Thin Fine Tailings
Mobile Equipment Trafficability 25 – 75 kPa

(Fair and Beier, IOSTC 2012)
Effects of Freeze/thaw on solids content and shear strength of a centrifuge cake under lab controlled conditions.

Flume (1.5 m x 0.5 m x 1 m)

Cake deposition (55%)

Freezing plate

Dessicated cake

Thawed cake

Dessicated cake
Geotechnical characteristics of a frozen and thawed centrifuge cake

[A] initial cake surface
[B] surface following freeze/thaw
[C]: surface after further settling/evaporation (2 years)
Effects of F/T on the consolidation properties and shear strength of a centrifuge cake

[Graphs showing consolidation properties and shear strength comparisons between untreated and 1 cycle F/T samples.]
Summary and Conclusions

- Current promising dewatering technologies such as thickening or centrifugation alone cannot achieve the levels of solids content and shear strength necessary for soft deposit capping or to establish a trafficable surface.

- Additional dewatering technologies are required such:
  - freeze/thaw
  - Atmospheric drying/shrinkage

(0) = Untreated MFT
(1) = Centrifugation
(2) = Freeze/thaw
(3) = 2-years Self-settling, shrinkage/evaporation
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Thank you for your attention

Merci

The real Canadian winter (freeze and thaw)
Canada’s Oil Sands

Alberta

Canada

Overburden

Oil sand ore layer

Clay layer

Surface mining

Alberta's boreal forest (381,000 km²)
oil sands deposits (142,200 km²)
oil sands surface mineable area (4,800 km²)
oil sands mineable area cleared or disturbed as of Dec 31, 2012 (767 km²)
FFT Volume Challenge

Fine Tailings Volume (Mm³)

- Business as Usual Fluid Tailings Projection
- Directive 074 (new tailings)
- Historic Fluid Tailings Production
- Tailings Management Framework (existing and new tailings)

(AB Go’vt 2015)