Ice Test by Hydro Quebec IREQ Institute
STUDY OF WATERPROOFING REVETMENTS
FOR THE UPSTREAM FACE OF CONCRETE DAMS

FINAL REPORT

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ICOLD European Working Group for Geomembranes and Geosynthetics as Facing Materials
2010 Tests

1300 lbs concrete
2 ice blocks
2/10 x 21 inch

Drag distance
6.5 ft / block

Effective Pressure
83,500 lbf/ ft²
Figure 154: Abrasion test in course (large load).

Figure 155: Craters left by the passage of the corner of an ice block (no visible damage).

Figure 156: Abrasion test in course at -15 °C.

Figure 157: Craters left by the passage of the corner of an ice block at - \( °C \) (no visible damage).

Trial 1 – 40-50°F
20 cycles
No damage
Small depression

Trial 2 – 40-50°F
With sand
10 cycles
No damage
Small scratches

Trial 3 – 5°F
20 cycles
No damage
Small depression
Special geomembrane formulation for cold weather

PVC phatalate plasticizers vs PVC sebacate plasticizers

Carpi / Flag
December 22 2005
GRAVITY DAMS
BEHAVIOR AFTER FIRST IMPOUNDMENT

- Saturated concrete
- Unsaturated concrete
GRAVITY DAMS
GENERAL BEHAVIOR OVER TIME

- CRACKS
- INFILTRATIONS
- CLOGGING OF DRAINS
- SATURATION OF CONCRETE
- UPLIFT PRESSURES

Saturated concrete
Unsaturated concrete
WATERPROOFING SYSTEM ON EXISTING DAMS

THE CONCEPT
(CONSTRUCTION)

- Upper sealing
- Existing surface
- Air space & drainage layer
- Watertight geomembrane
- Water collection system
- Watertight geomembrane
- New concrete beam
- Free flow water discharge
- Contact grouting
- Grout curtain
- Anchor
- Line of watertightness with drainage
- Line of watertightness
EFFECTIVENESS OF DRAINAGE SYSTEM IN SATURATED EXISTING DAMS

WITHOUT GEOMEMBRANE

WITH DRAINED GEOMEMBRANE

FRONT VIEW

Max. Water Elevation

Wet surface

FRONT VIEW BEHIND GEOMEMBRANE

Dry surface

Drainage discharge

Wet surface
UPPER BLUE DAM

• Country: United States (Colorado)
• Elevation at crest: 11,742 feet
• Latitude: 39°N
• Dam height: 72 feet
• Type of face: bituminious concrete
• Geocomposite installation completed 2007
• Surface of upstream face: 71,350 sq. feet
• Installation time: 2 months
• Construction of a new plinth: no
Upper Blue face condition
First, install tensioning profiles to hold geocomposite against wind force
Second, install thick geotextile cushioning layer over rough spots
Third, install the top seal with geocomposite
Fourth in rough areas install geogrid to bridge depressions of face.
Fifth, install thick geotextile over the geogrid
Sixth, install the PVC geocomposite
Seven, weld geocomposite sheets (2.1 m wide) together
Eight, install the top tensioning profile
Membrane installed but not tensioned on left, on right after tensioning profile installed.
Ninth, install cap strip over tensioning profile
Tenth, remove the asphalt to expose concrete plinth
Eleventh, install perimeter seal with anchors
Twelve, install geogrid
Thirteen, install geonet drainage collection layer
Fourteen, install sacrificial geocomposite
Fifteen, install gcocomposite over plinth
Sixteen, install battens with coverstrip in ice area
Seventeen, core drain through asphalt
Eigteen, install drain plates (4) over drain holes
Last step, complete installation of batten strip perimeter seal
Statistics on dams in cold weather with exposed PVC geomembranes

- PVC geomembranes are elastic and conform to subgrade
- PVC can be formulated for low temperatures
- Ice does not adhere to PVC
- At least 55+ cold weather installations worldwide
- Oldest – 37 years 1980 (Italy)
- Highest Latitude – 59.5° N (Mongolia)
- Highest Altitude – 11,742 fasl (Colorado)
- More than 3,700,000 sq. feet installed in cold climates
- More than 700 years of service for exposed PVC geomembrane installations in cold climates
The End

Gem dam, USA, 84 feet, 2007
2008 ASDSO National Rehabilitation Project of the Year
De-icing system
PVC geomembrane resist impact by Rip Rap
NO damage to the PVC geomembrane under Rip Rap
JOINT PROTECTION
(Detail)

Concrete slab

80x8 stainless steel flat profile

SIBELON® CNT 4400 geocomposite

SIBELON® CNT 4400 geocomposite (double sacrificial layer)

80x3 rubber gasket

Epoxy bedding mortar

Fischer FH-II SK 41 expansion anchor @ 500 mm

M 12 stainless steel threaded bar @ 150 mm

Concrete

M 12 stainless steel threaded bar @ 150 mm

Chemical anchor

NOTE:
- Dimensions are in mm unless noted otherwise
- All materials are made of Stainless Steel AISI 304 unless otherwise specified

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