Stopping Leakage in Canals in the Dry and in Flowing Water Conditions by PVC Geomembranes

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Dynamic action of water is a heavy load condition which deteriorates canals.

Geomembranes have been used for rehabilitation and new construction of canals since the late 1940’s.
Among the large family of geomembranes, PVC geocomposites have a very long record of successful applications in canals, both in exposed and covered position.
The main benefits of PVC geocomposite systems in canals are:

- They watertighten the entire surface, including joints
- They withstand action of UV, ice, debris
- They withstand differential settlements
- Because of their smoothness, they allow increase of water flow
- They allow monitoring the performance

Exposed PVC geocomposites are smooth and allow increase of water flow.
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Exposed PVC geocomposites allow for high water velocity.
Exposed PVC geocomposites are smooth and they allow increase of the free board.

Exposed PVC geocomposites resist high turbulence.
PVC geocomposites resist impacts by massive stones

PVC geocomposites are not punctured by the placement of heavy protection
The main criteria for designing a PVC geocomposite waterproofing system are:

- For covered geomembranes, there shall be sufficient weight of ballast and puncture resistance to ballast.

- For exposed geomembranes, they shall be strongly anchored to the subgrade to cope with water velocity, they shall be UV resistant, they shall have a drainage system.
CONCEPTS FOR ANCHORING PVC GEOCOMPOSITES IN CANALS:

examples

PVC GEOCOMPOSITE TOTALLY COVERED

Waterproofing geomembrane placed over the deteriorated subgrade and covered by reinforced concrete/shotcrete
IGS Technical Committee on Hydraulics
Improving the Performance of Canals with Geosynthetics

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19

GEOMPOSITE TOTALLY COVERED

Reinforced concrete cover on slopes and bottom

Ala Bussolengo, Italy 1973

Solution mainly used in pioneer projects, when there was less confidence in performance of exposed geomembranes

20

GEOMPOSITE COVERED ONLY ON INVERT

It applies to canals with heavy traffic for cleaning operations on invert
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The geocomposite is anchored with lines of stainless-steel profiles. Number, type, shape of profiles depends on water velocity, cross section and strength of subgrade.

40+ years in operation, no maintenance required

Poschiavino, Italy 1979
Fully exposed PVC geocomposite on slopes and invert.
Mittlere Isar Strogenbauwerk, Germany 2000.

Mittlere Isar Strogenbauwerk, Germany 2000.
Exposed geocomposite allowed for 90% water flow increase

Senhora do Porto canal, Portugal, 1993/94
Heightening of walls: 10%

Objective: waterproof and increase water flow

SMOOTH GEOMEMBRANES ADEQUATELY ANCHORED CAN INCREASE WATER FLOW

Exposed SIBELON® geocomposite
Heightening of walls: 10%

Excavation for drainage collection

Exposed SIBELON® geocomposite

Drainage geonet

PVC drainage pipe embedded in gravel
Senhora do Porto, Portugal - Exposed geocomposite installed in 1994. stopped leakage + smoothness + heightening of walls 10% = 90% increase in water flow

Use: hydropower
In earthen canals, for various types of subgrade, different anchoring and ballasting solutions are available. The ballasting of the geomembrane is obtained by creating a berm in the upper part of the slope.
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The ballasting of the geomembrane is obtained by adding soil in the upper part of the slope, supported by a beam.
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The installation of the PVC geocomposite has no adverse aesthetical environmental impact.

Pernegg, Austria 2010

Tekapo canal remediation, New Zealand, 470,000 m²
Installation in 12 weeks
The new frontier is to install the geomembrane underwater without emptying the canal or not even stopping/decreasing the water flow.
We at Carpi have been the first company in the world to install geomembranes underwater in dams, where the water is not moving.

So far, more than 15 underwater installations successfully completed.

3 - Video Turimquire

Underwater installation of a Carpi exposed geomembrane system at Las Canalitas CFRD (Turimiquire), Venezuela.
For installation of geomembranes in canals in flowing water, to reduce costs by avoiding underwater installation of stainless-steel profiles, Carpi developed a revolutionary solution:

**An innovative impermeable heavy-duty zip**
For waterproofing of canals, where excavation of berms is not convenient, Carpi has developed a watertight mattress:

The SIBELONMAT®
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## Conclusions

- Installation of PVC geomembrane systems can be performed totally underwater
- At any depth, at water velocity up to 1 m/s, on the full section of the canal
- No impact on canal operation
- Effective long-lasting solution to stop leakage
- Can be installed to repair canals and embankment dams, or as upstream blanket
- Can be used in new construction of embankment dams and canals

## Lower Maintenance Costs for Carpi geocomposites

- No scheduled or preventative maintenance for geocomposite system
- No moving components that can fail
- Monitoring system to locate any damaged area within less than 1 square meter.
- After more than 1,000,000 square meters of installations with more than 500 years of cumulated service history, customers have experienced $0 maintenance costs
THANK YOU