DIKE MONITORING

Elke Thiele

Reinhard Helbig, Holger Erth,
Saxon Textile Research Institute
Chemnitz, Germany

Katerina Krebber, Niels Nöther and Aleksander Wosniok
Federal Institute for Materials Research and Testing,
Berlin, Germany

Duration: 2005-2008

Funding Project Management Coordination

4th International Symposium on Flood Defence, Toronto, May 6-8, 2008
DIKE MONITORING

Motivation to start this research project

Problem
In case of an extreme flood dikes may lose their integrity

Goal: safer dikes
• Reinforcing
• monitoring

Solution
Integration of sensor systems into the textile structure

source: BBG mbH
Components of a textile- fiber optical sensor system

- Measuring instruments
- Connecting system (forerunner fibers, end-runner fibers, plugs, ..)
- Fiber optical sensors (glass materials, plastic materials)
- Textile structure to position fiber optical sensors (at stfi: by means of knitting)
DIKE MONITORING

The optical fibers are being strained

Optical signals

Soil displacement

Control Center

Communication

measurement system based on Stimulated Brillouin Scattering SBS
DIKE MONITORING

ADVANTAGES

- Only light is transported, no electric current
- No puncture in case of a lightning strike
- System works under extreme conditions (moisture, wetness, vibration, radioactivity)
- The same fibers as used in telecommunication = low priced
DIKE MONITORING

DISADVANTAGES

- Silica optical fibers are sensitive to bending and mechanical stress
- Minimum bending radius without increase of optical attenuation is 32 mm
- Fibers would break if they were not protected by coating and cabling materials
Components of the novel multifunctional textile system

Optical fibers

MATERIAL

PVC
PU
Kevlar for strain relief
PVC
acrylate buffer
optical fiber
Components of the novel multifunctional textile system

Textile material

- Polypropylene (PP)
- Polyethylene (PE)
- Polyester (PET)
- Glass
- Aramid

source: R. Hufenus "Bauen mit Geokunststoffen"
DIKE MONITORING

Vliesraschelmaschine RS 3 MSUS-V with weft insertion

Specification:
- special warp knitting machine
- parameters
  - gauge 6 E
  - 3 bars (1 ground bar, 2 guide bars to take up the sensors and the strengthening fibres)
  - working width 165 inches
Critical mechanical impacts on fiber optical sensors

Sensor fibers or reinforcing fibers

Weft insertion

Ground yarn

Nonwoven
Analysing methods of critical mechanical impacts on fiber optical sensors

Test with special Polymer optical fiber (POF)
Analysing methods of critical mechanical impacts on fiber optical sensors

OTDR equipment used to check the quality of fiber optical sensors during the manufacturing process
Textile machine adaptation
Analysing methods of critical mechanical impacts on fiber optical sensors are the basis for the textile machine adaptation
Single needle bar raschel knitting machine RS 3 MSUS-V

Advantages:
- very dense,
- semi-open or
- open structures can be produced

Reinforcing fibers in 0° and 90° direction
sensors in 0° direction
DIKE MONITORING

FIELD TESTS

Dike of the river Mulde

1\textsuperscript{st} test in Sollnitz near the town of Dessau

4\textsuperscript{th} International Symposium on Flood Defence, Toronto, May 6-8, 2008
DIKE MONITORING

FIELD TESTS
DIKE MONITORING

FIELD TESTS
DIKE MONITORING

FIELD TESTS

gravity dam in Solina, Poland

2nd test in Solina, Poland downriver of a retaining wall

4th International Symposium on Flood Defence, Toronto, May 6-8, 2008
DIKE MONITORING

FIELD TESTS
gravity dam in Swinna Poremba, Poland

3rd test in Swinna Poremba, Poland downriver of a retaining wall
DIKE MONITORING

4th test in Lab dike at the Franzius Institute at the University of Hannover

4th International Symposium on Flood Defence, Toronto, May 6-8, 2008
DIKE MONITORING

Integration of lifting bags to initiate failures

LAB TEST

4th International Symposium on Flood Defence, Toronto, May 6-8, 2008
Integration of the geotextile into the lab dike
DIKE MONITORING

Brillouin effect in optical fibers

3 bar

Brillouin effect in optical fibers

6 bar

LAB TEST

4th International Symposium on Flood Defence, Toronto, May 6-8, 2008
DIKE MONITORING

Optimization of the measurement system

Calibration of the geotextile-fiber optical sensor system

SCHEDULE
DIKE MONITORING

Research has been carried out in the framework of the Risk Management of Extreme Flood Events (RIMAX) program of the Federal Ministry of Education and Research within the project "Sensorbasierte Geotextilien zur Deichertüchtigung (FKZ 02WH0573)".

We would like to thank our partners
Bauberatung Geokunststoffe GmbH & Co. KG,
Glötzl Gesellschaft für Baumesstechnik mbH,
Franzius-Institut für Wasserbau und Küsteningenieurwesen at the University of Hannover
KARL MAYER malimo Textilmaschinenfabrik GmbH and
fiberware Generalunternehmen für Nachrichtentechnik GmbH.

Thank you very much for your attention!!