GEOSYNTHETICS IN THE ROAD INFRASTRUCTURE

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Using intelligent geosynthetics in subsoil reinforcement

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A REMAINING PROBLEM

Structures over Cavities and Soil Subsidence

Conventional Problem Solving

1. Use of conventional materials (concrete, steel)

This might results in extrem high cost!!

2. Use of geosynthetic reinforcement

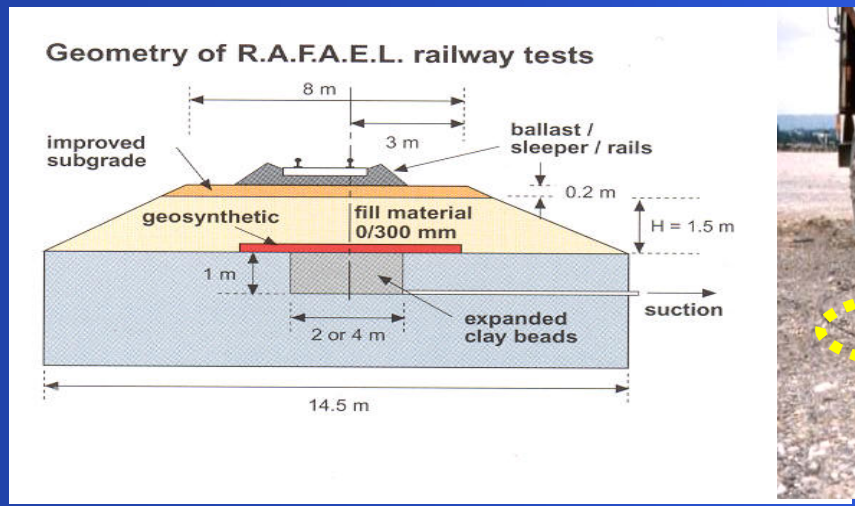
To cover 99% of the risk overdesign is most probably.

but →

Unpredictable soil formation can still lead to severe damage of the project !

IN THE BEGINNING……

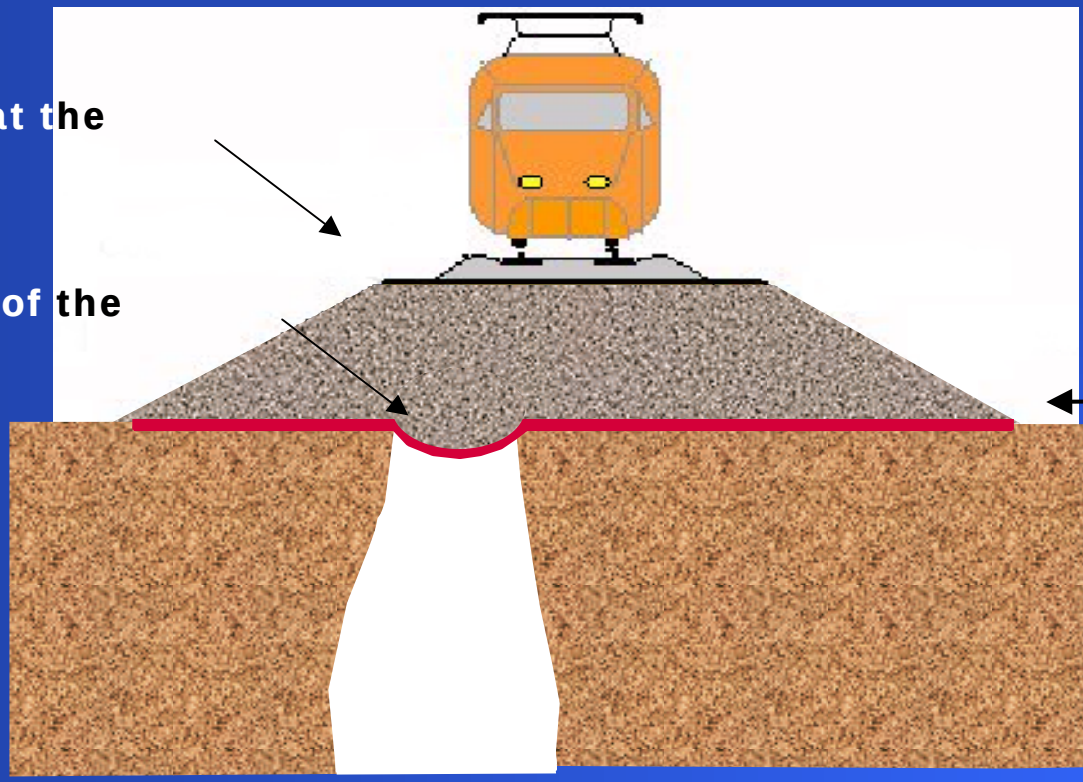
Reinforcement of Embankment over Soil Subsidence (Cavity)



Rafael project for French railways, motorways in 1997

RAFAEL Project

Design of the reinforcement over soil subsidence



➔ Warning system needed (on development of the cavity)

The Answer:
GEODETECT – Reinforcement and Monitoring

- **Detection of incidents in soil (strain or failure)**
  Any events in the underground resulting in strain of Geodetect can be detected.

- **Strain measurement**
  Movements of earthwork structures and development of soil formations can be measured.

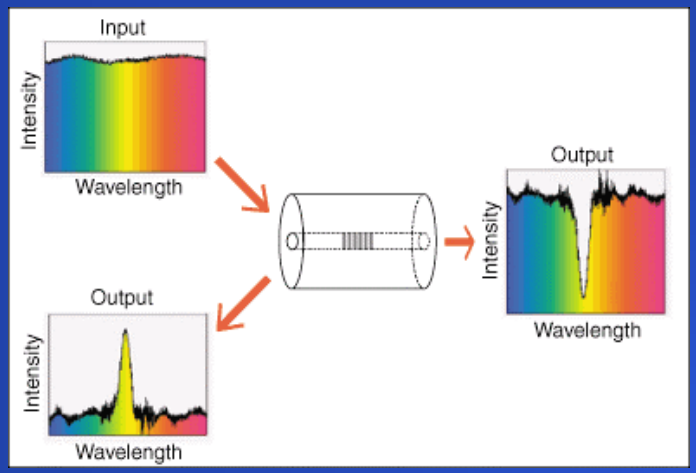
- **Alarm in real time**
  Any strain in Geodetect can lead to an immediate warning signal

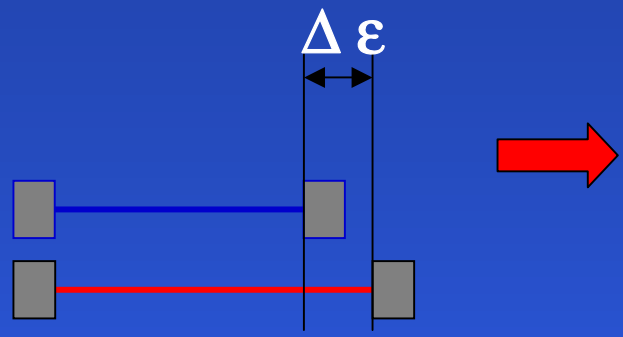
- **Location of incidents**
  The area of the event can be localized.

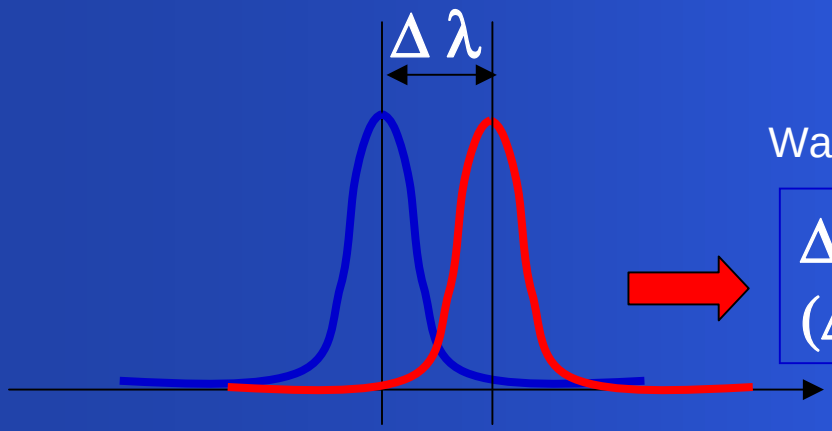
- **Reinforcement**
  Earthwork structures are reinforced according to the required design, taking into account possible economies due to the attached monitoring.

Principle of strain measurement

Modification of the fibre (eg stress): The reflected signal is modified

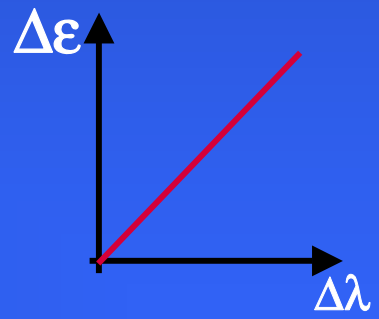






Wavelength nm

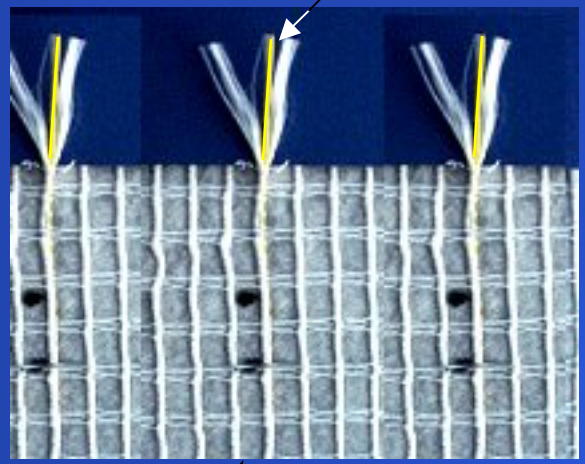
$$\Delta\varepsilon = \phi(\Delta\lambda)$$

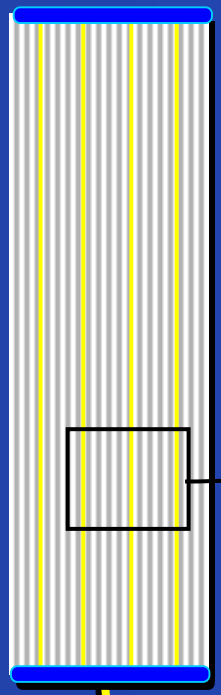


Because of the specific property of the Bragg Gratings, the elongation of the fibre may be read with the displacement of the characteristic wavelength.

GEODETECT
The System

Optical glas fibre





Geodetect

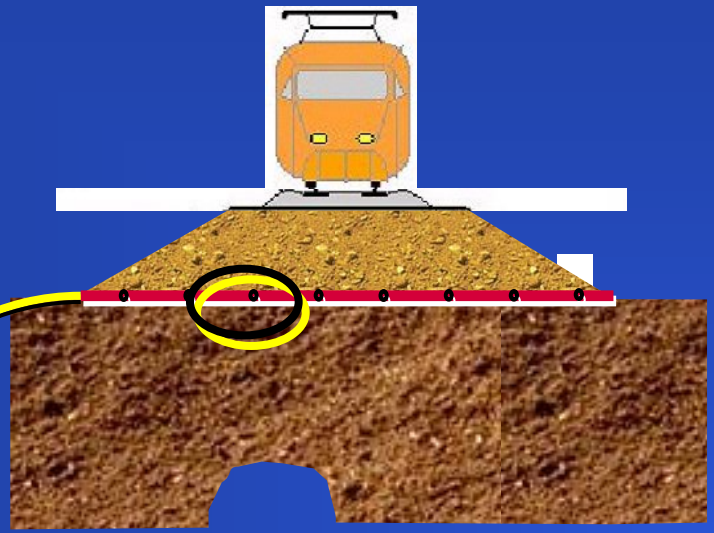
Optical switch

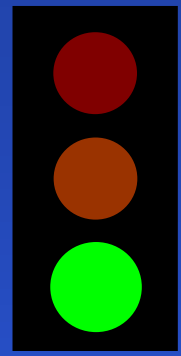
Outdoor cable

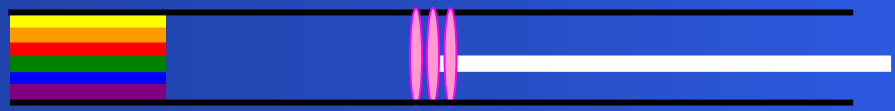
Information transfer:

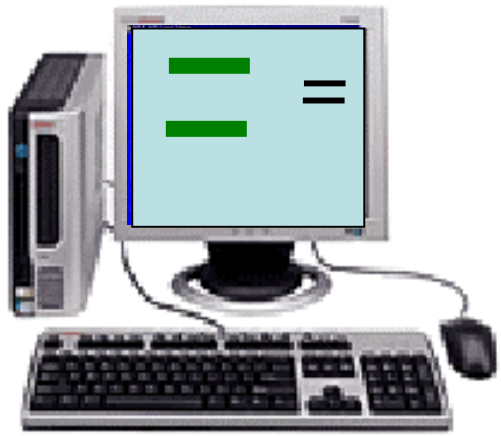
TCP/IP Modem GPRS

GEODETECT – Principle of Alarm System

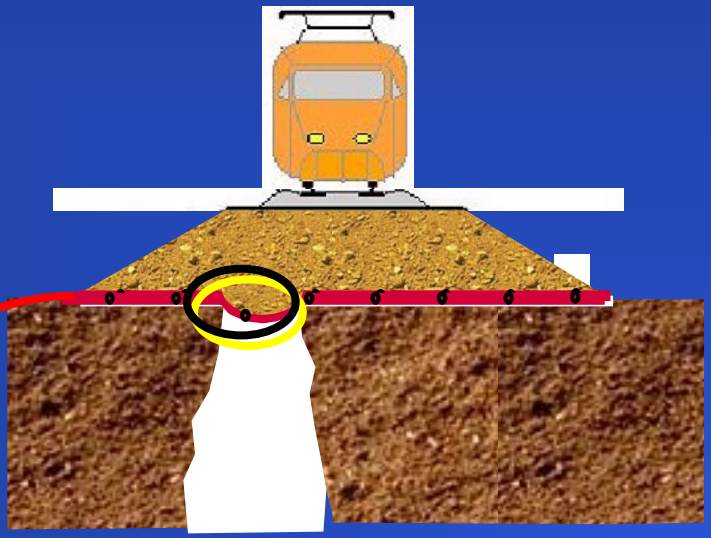


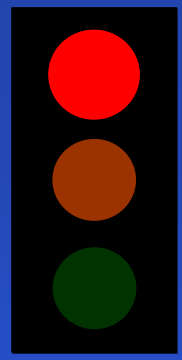


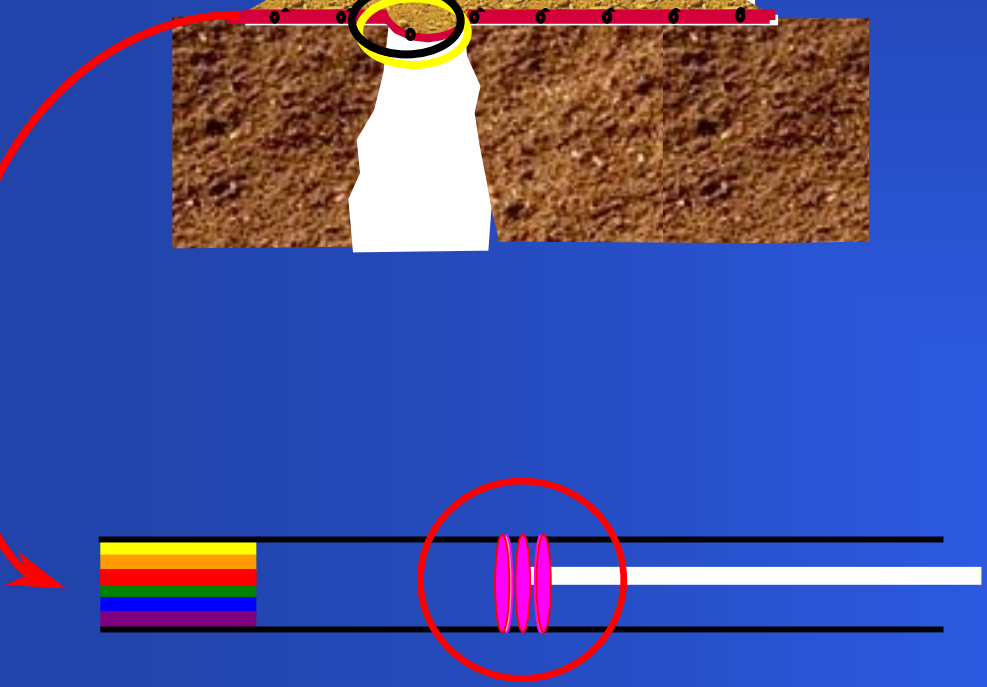




GEODETECT – Principle of Alarm System





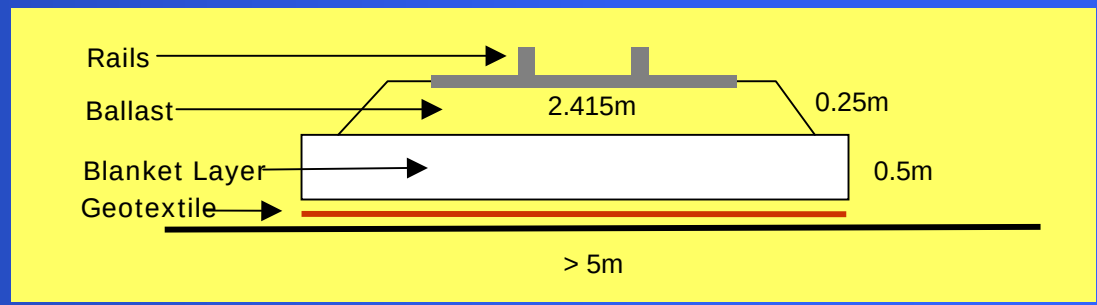


Case History 1

Railway Project Arbois, France 2004

Warning system to monitor soil subsidence (sinkholes) for French Railways (SNCF)

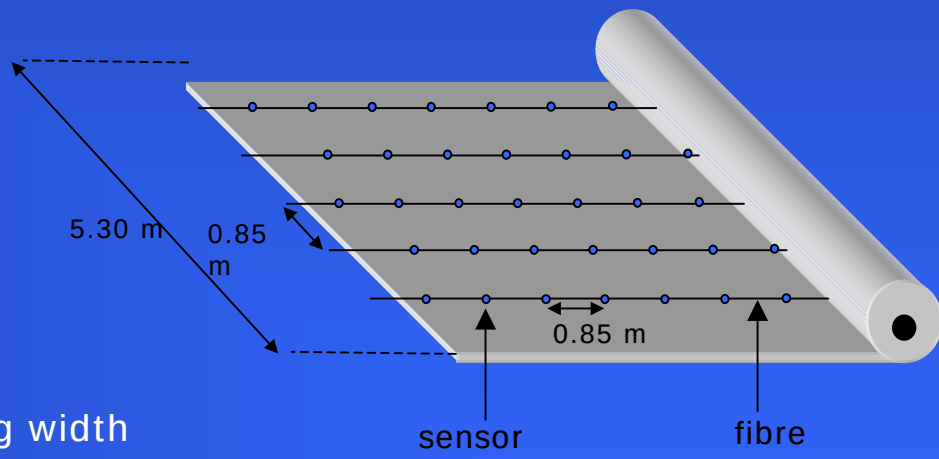
Monitoring area:
length of track 50m
width 5.3m



Case History 1

Railway Project Arbois, France 2004

Design criteria:
Warning criteria for surface settlement: 6mm
Slowdown criteria for surface settlement: 9mm
Intervention criteria for surface settlement: 21mm
(21mm corresponds to 2% strain in Geosynthetics)



Geodetect information:
- Tensile strength of geotextile 300kN/m
- 5 fibre optical cables at 0.85m spacing along width
- Sensor distance 0.85m
- Design with min. 1 sensor to detect hole diameter 1.2m
- Total of 300 sensors used

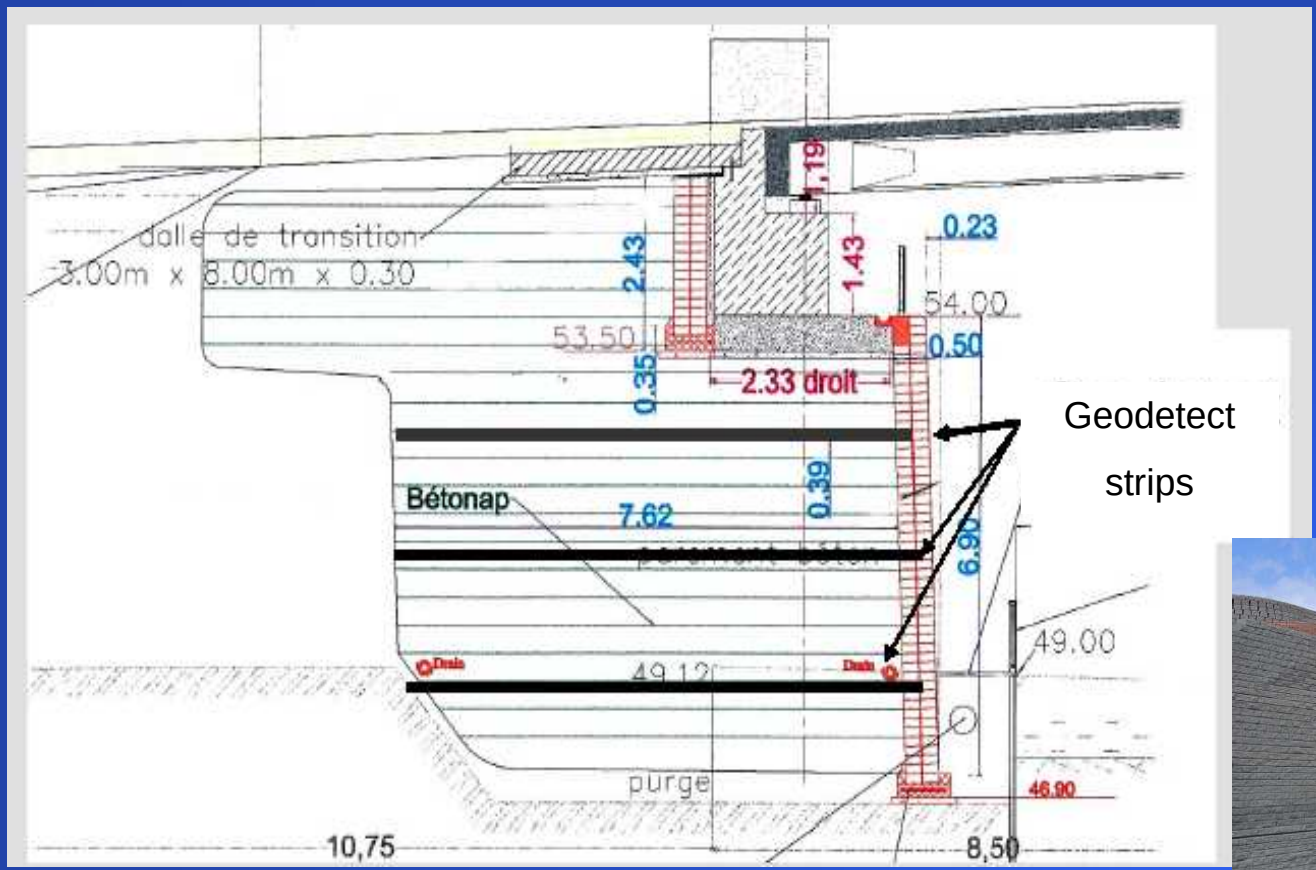
Case History 1

Railway Project Arbois, France 2004

- Night installation (11:00pm-5:00am) to prevent interruption of train service
- Ballast removed and soil excavated to 50cm
- Placement of pre-fabricated Geodetect roll

Case History 2

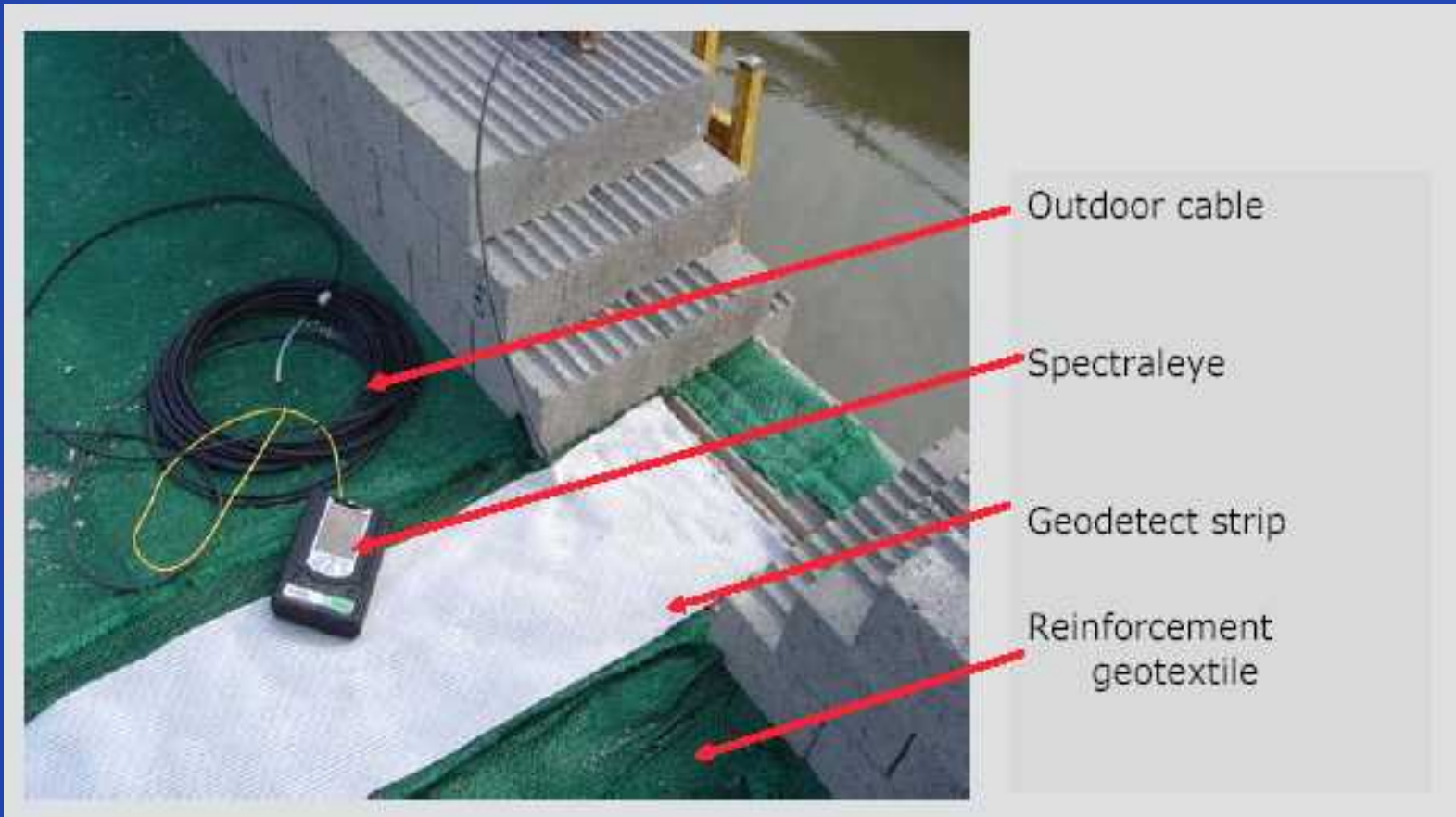
Geosynthetic Reinforced Bridge Abutment, St.Saturnin, France, 2004



Cross section of structure indicating location of Geodetect

Case History 2

Geosynthetic Reinforced Bridge Abutment, St.Saturnin, France, 2004



Geodetect installation

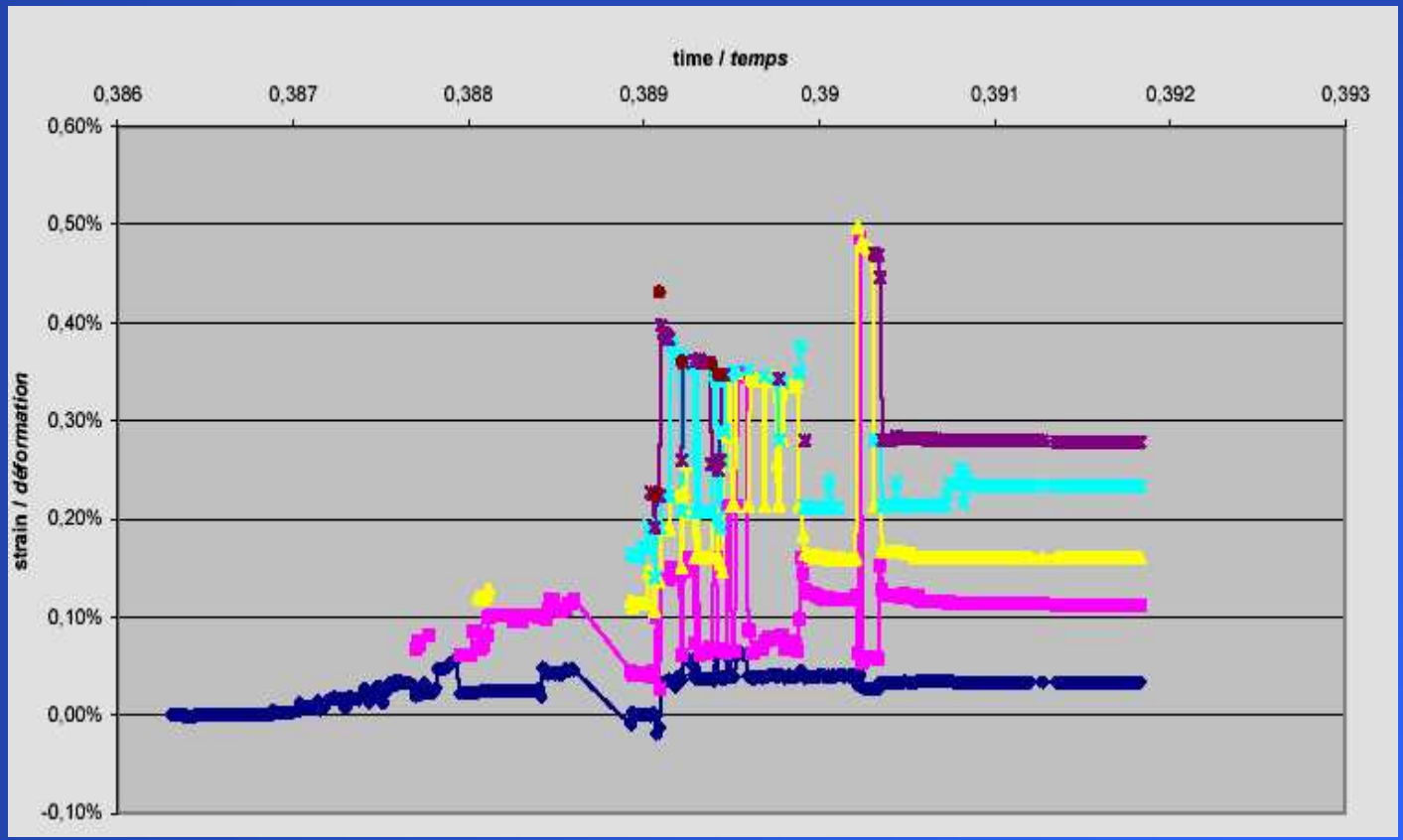
Case History 2

Geosynthetic Reinforced Bridge Abutment, St.Saturnin, France, 2004

Strain measurements with Geodetect

Case History 2

Geosynthetic Reinforced Bridge Abutment, St.Saturnin, France, 2004



Strains recorded in Geodetect

GEODETECT
Conclusion

<< Innovative Reinforcement and Monitoring System for Safe and Cost Effective Maintenance of Earthwork Constructions >>

- Measurement of strain of geosynthetic reinforcement in soil
- Analysis and alarm System
- High durability and long time resistance
- High accuracy: Strains of 0,003% can be registered
- Easy monitoring of large areas
- Simple handling and installation
- Industrial production