

Grout Evaluation of External PT Tendons

STEPHEN SCHORN



sixsense

Outline

- The Problem
- Capacitive probe
- Field Evaluation
- Project Example
- What do I get?
- Conclusion

The Problem

External Post-Tensioning



HDPE Ducts, Steel cable strands, Cement grout

Inspections in France



- During routine inspection, broken PT ducts were found
 - Detection of lack of cement grout (voids), white paste, corrosion of the steel cables

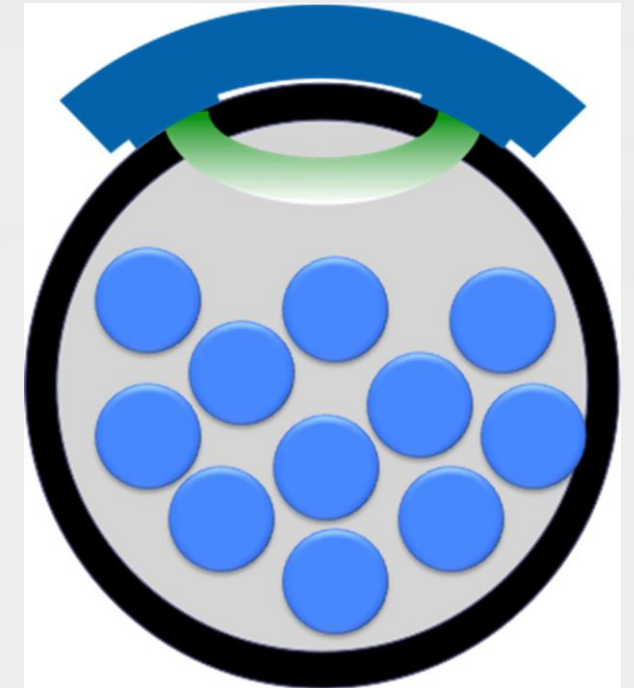
The Problem Continues



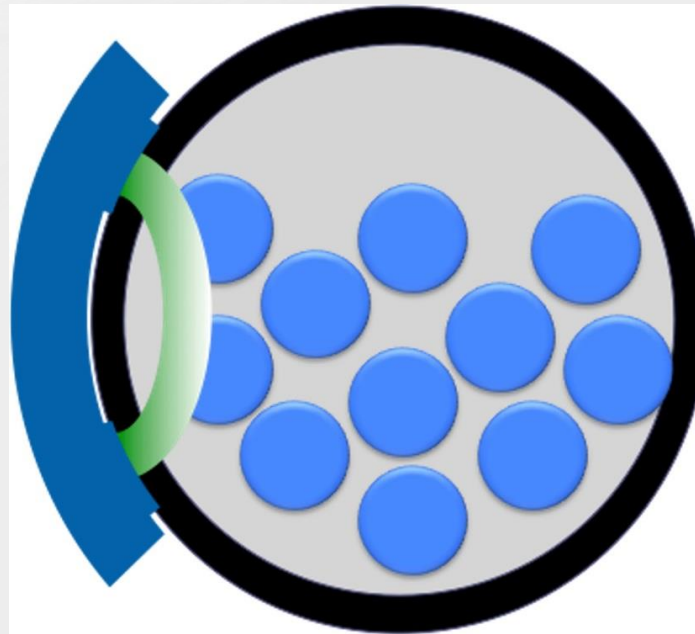
Capacitive Probe

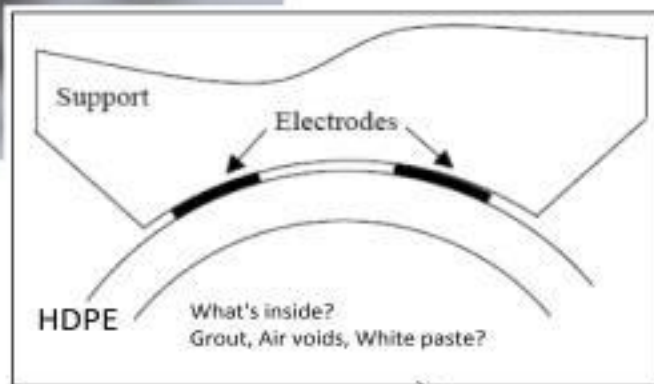
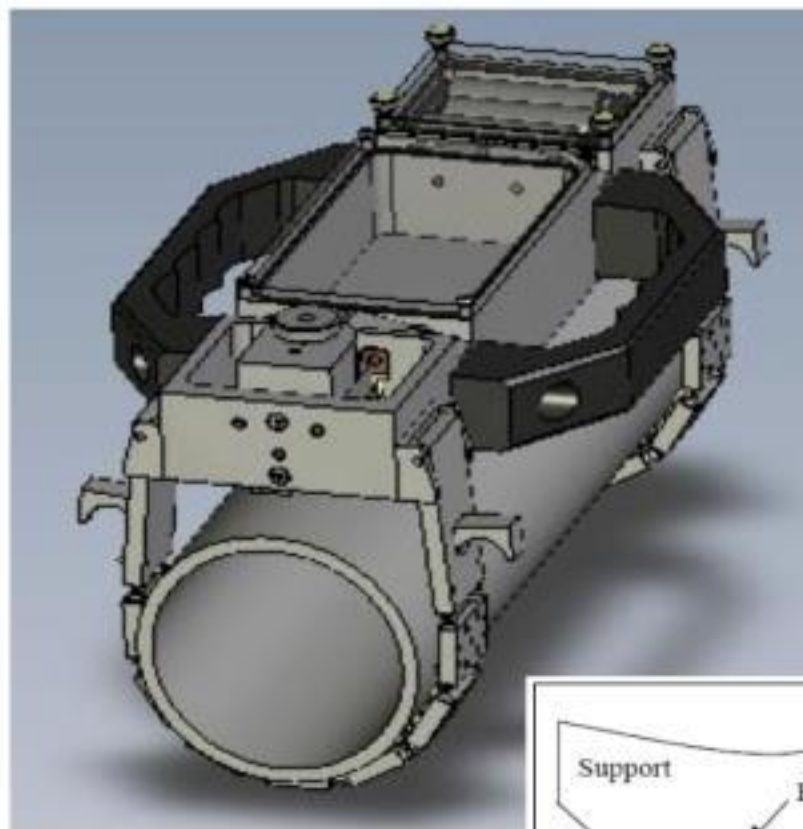
Capacitive Principle

- Capacitive method
- Sensitive to differences in electrical properties of materials
- This will indicate the material or combination of materials present
 - Reveal air voids
 - White paste
 - Soft grout
 - Areas of increased potential for corrosion
- Inspection depth of 1.5in



- It can be moved along or around the duct
- To provide a full mapping of the cross section, do a 360 degree rotation

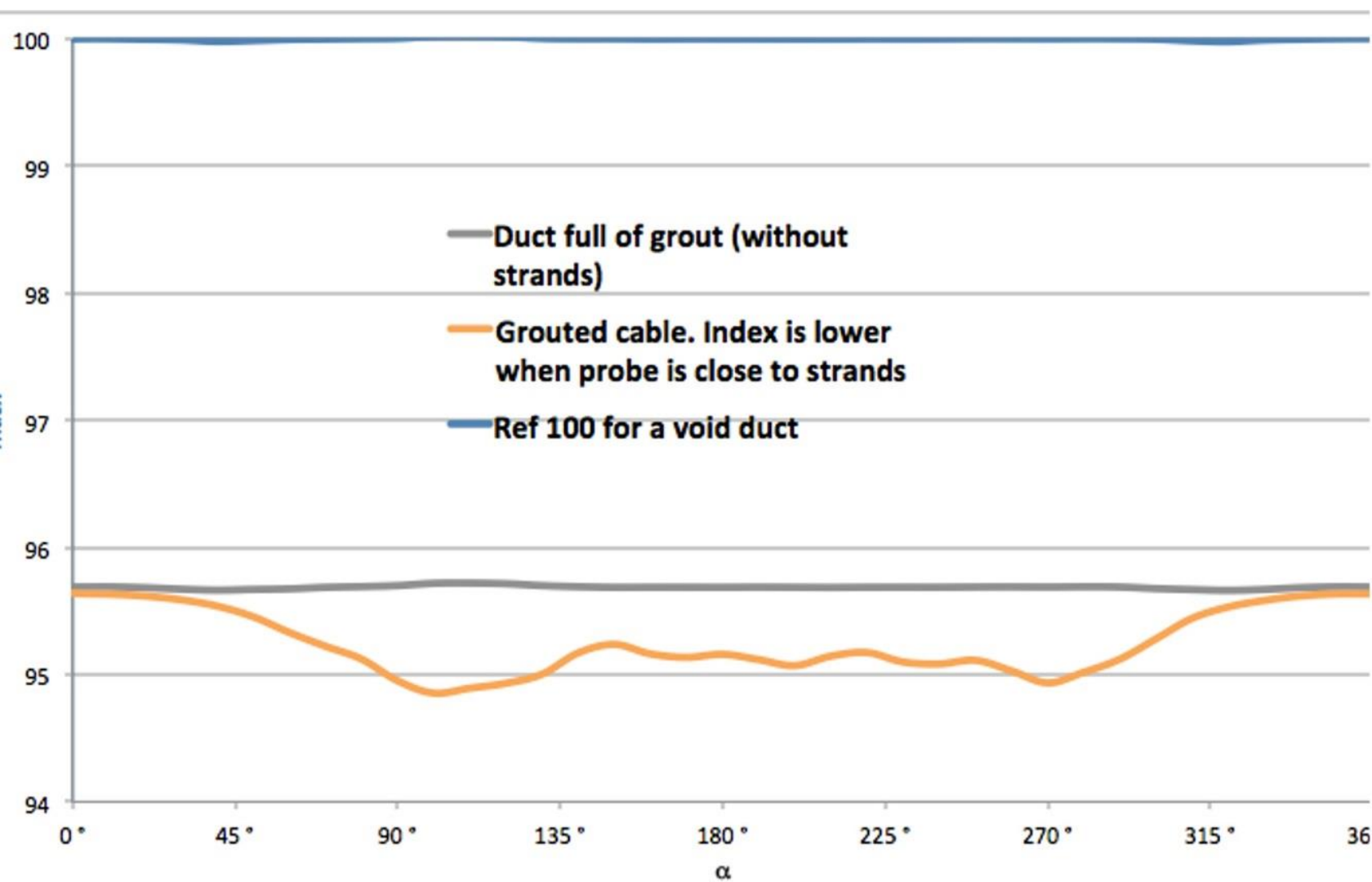




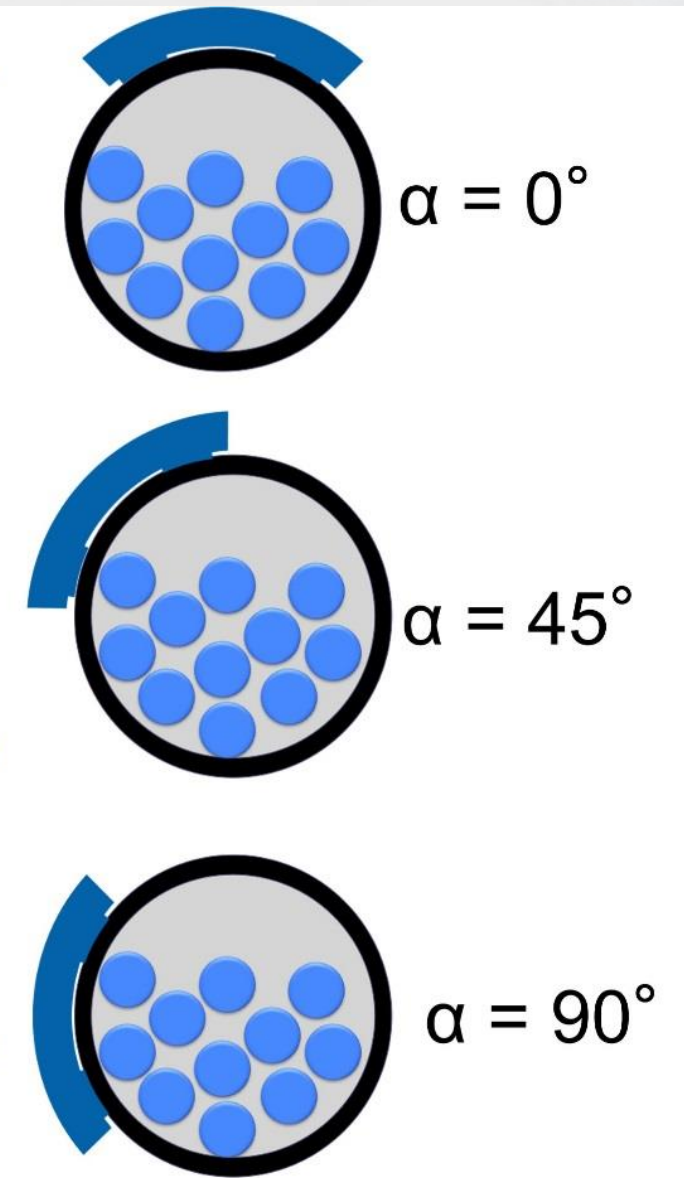


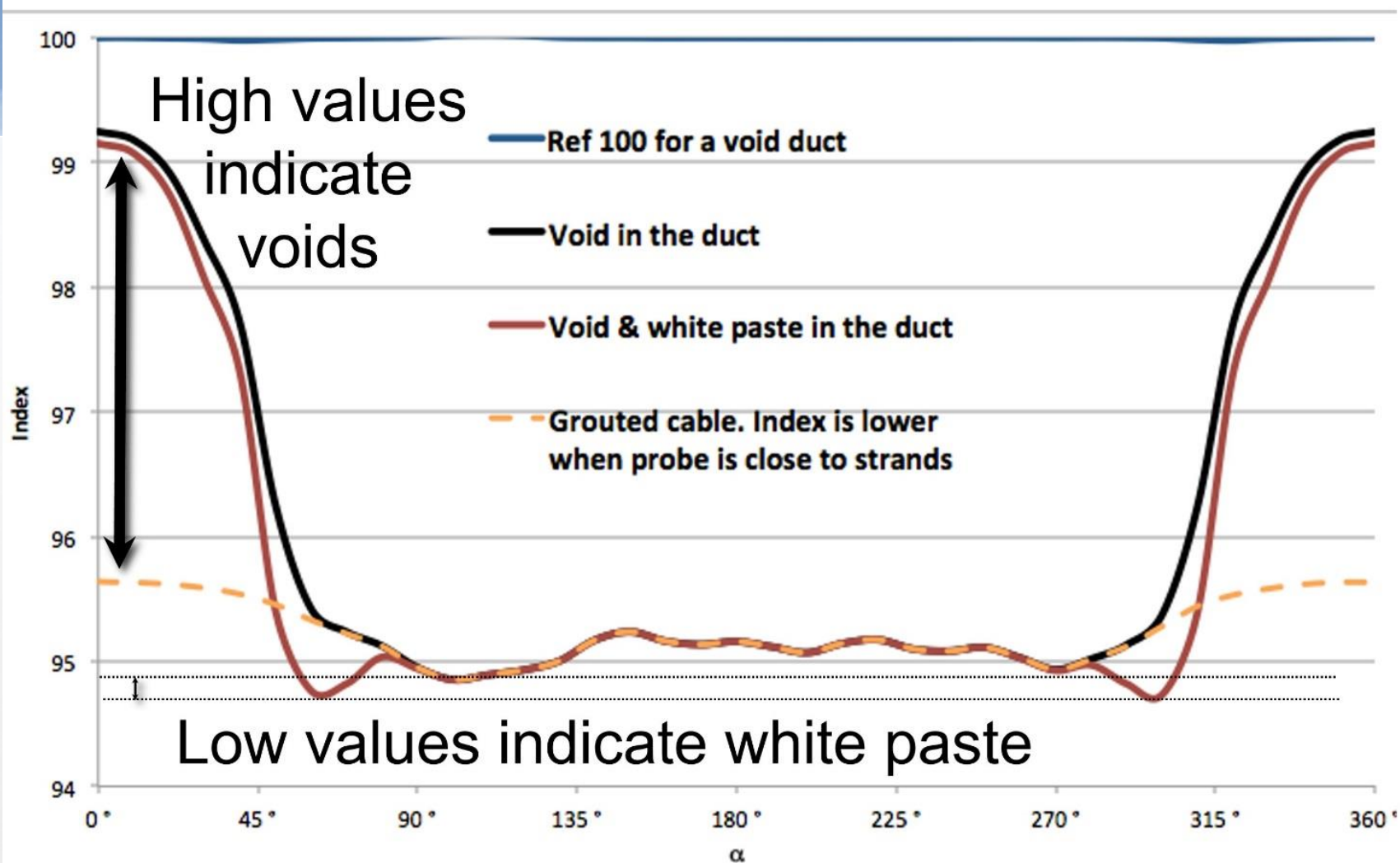
NATIONAL BRIDGE PRESERVATION PARTNERSHIP CONFERENCE 2018

PRACTICES WE CAN NOT AFFORD TO DEFER

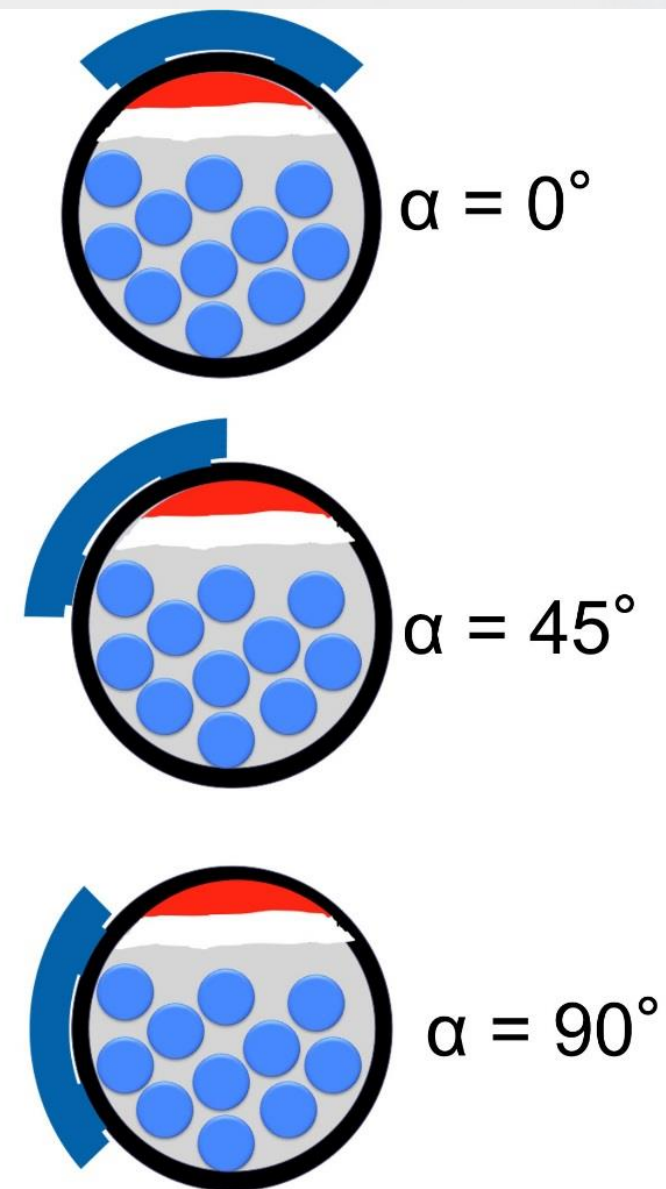


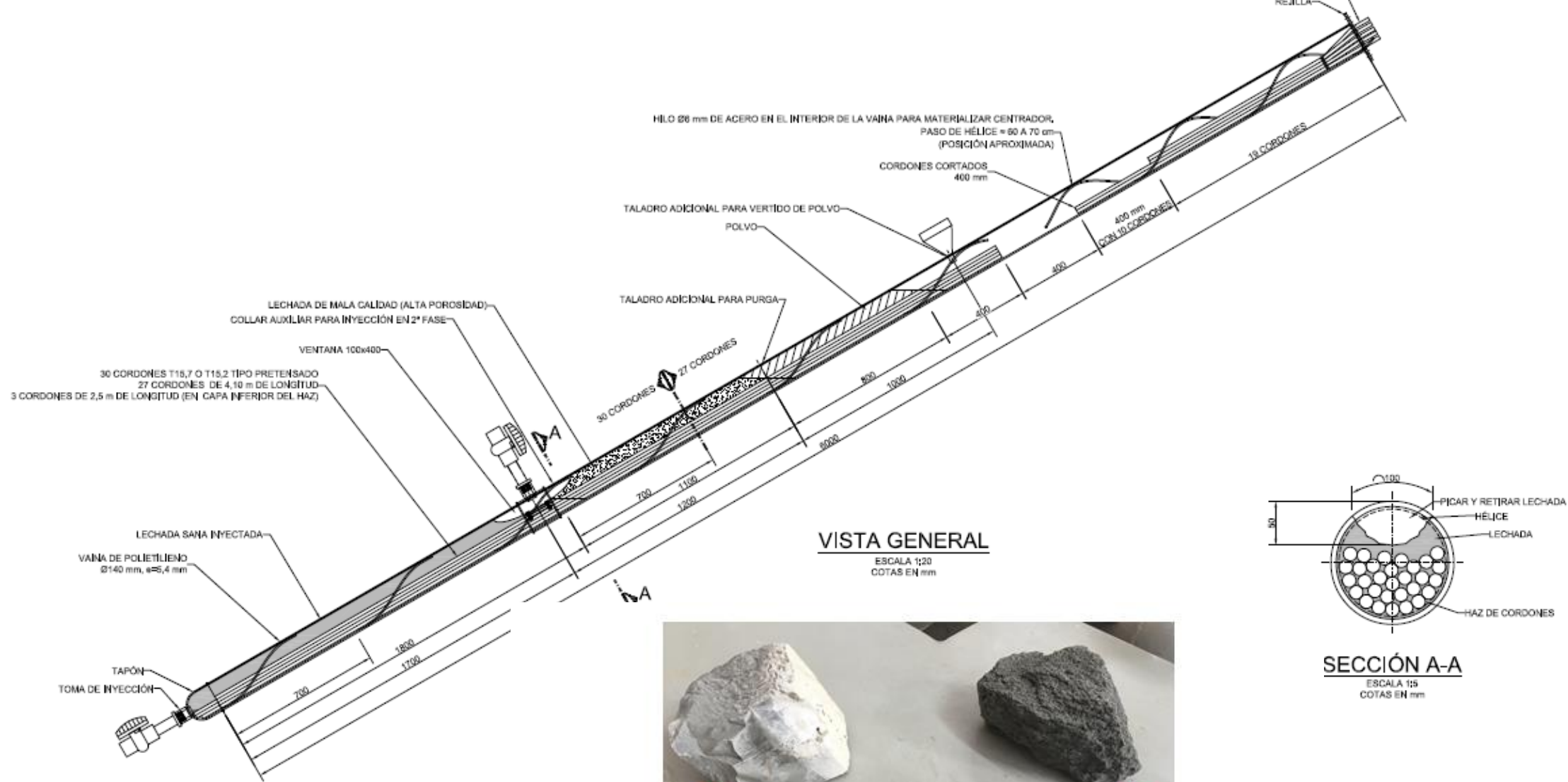
Typical readings for a cable with no grouting defect





Typical readings for a cable with grouting defect

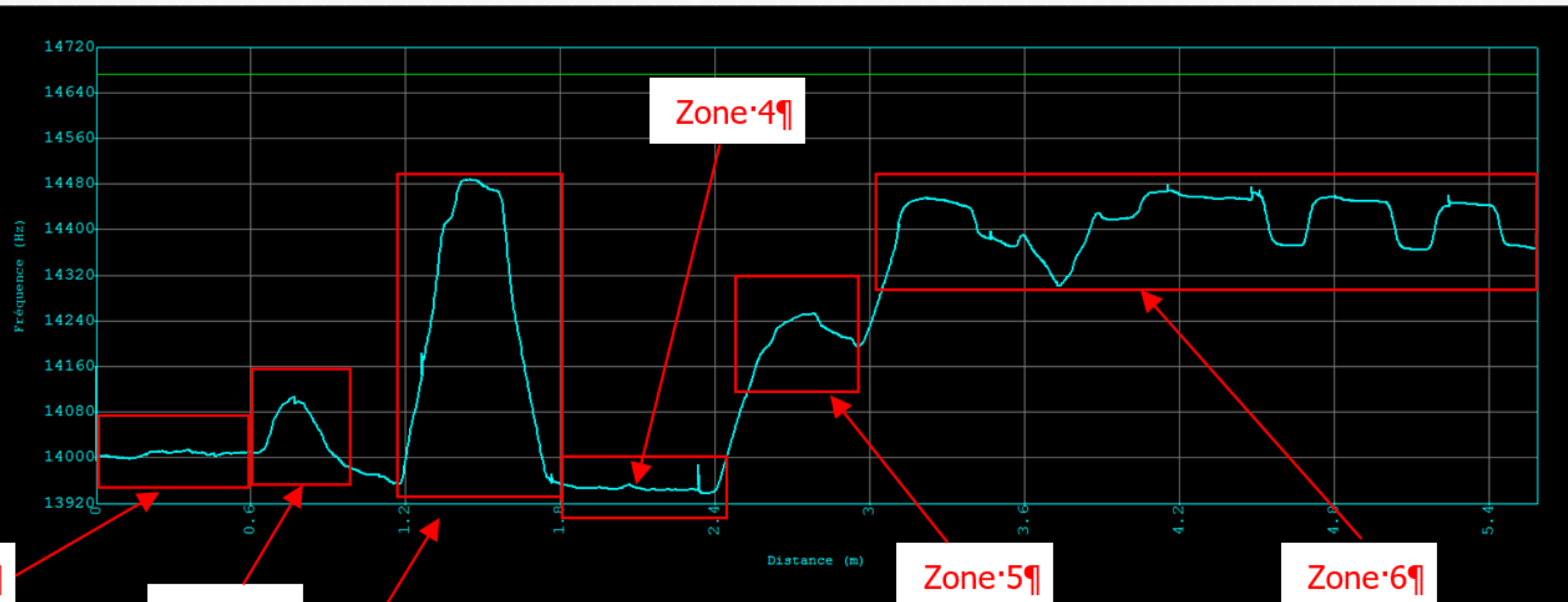




Good quality of grout

Bad quality of grout

Gravels of cement



Zone 2

Zone 3

Fréquence absolue mesurée en Hz

Distance (m)

Rotation (deg)

Tension

f (Hz)

0

 $1/(F \cdot F)$

0.00



Imprimer

Conclusion essai

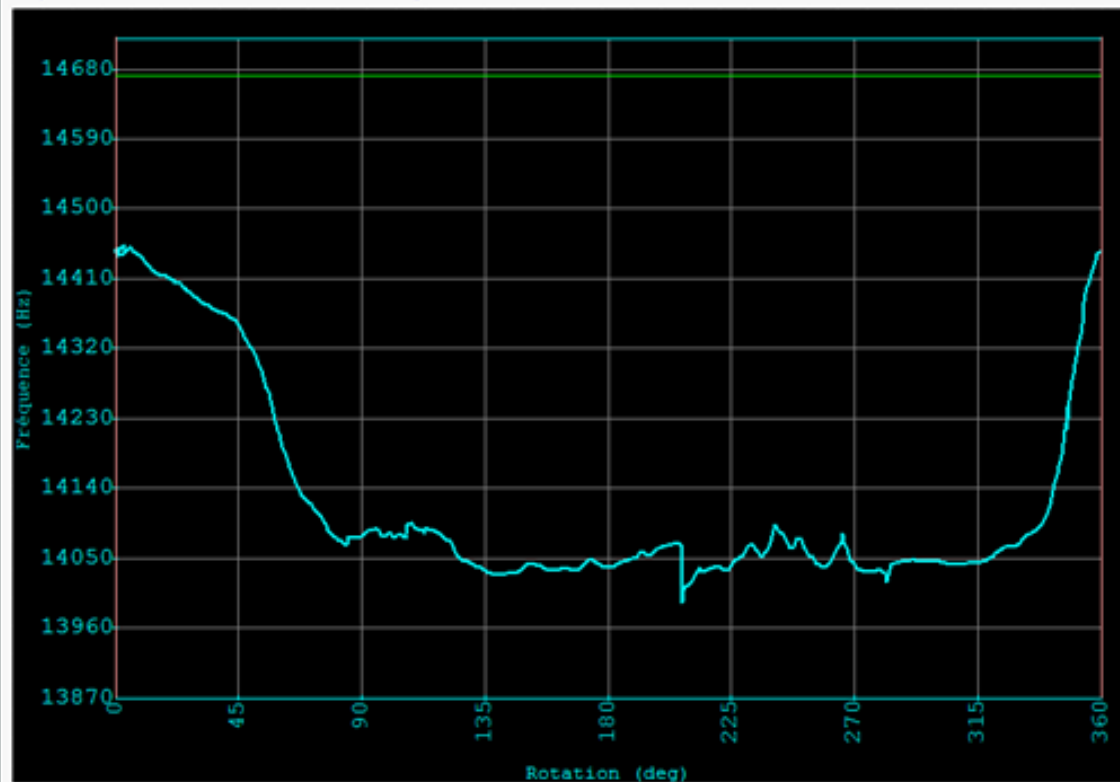
Conclusion session

Annexes

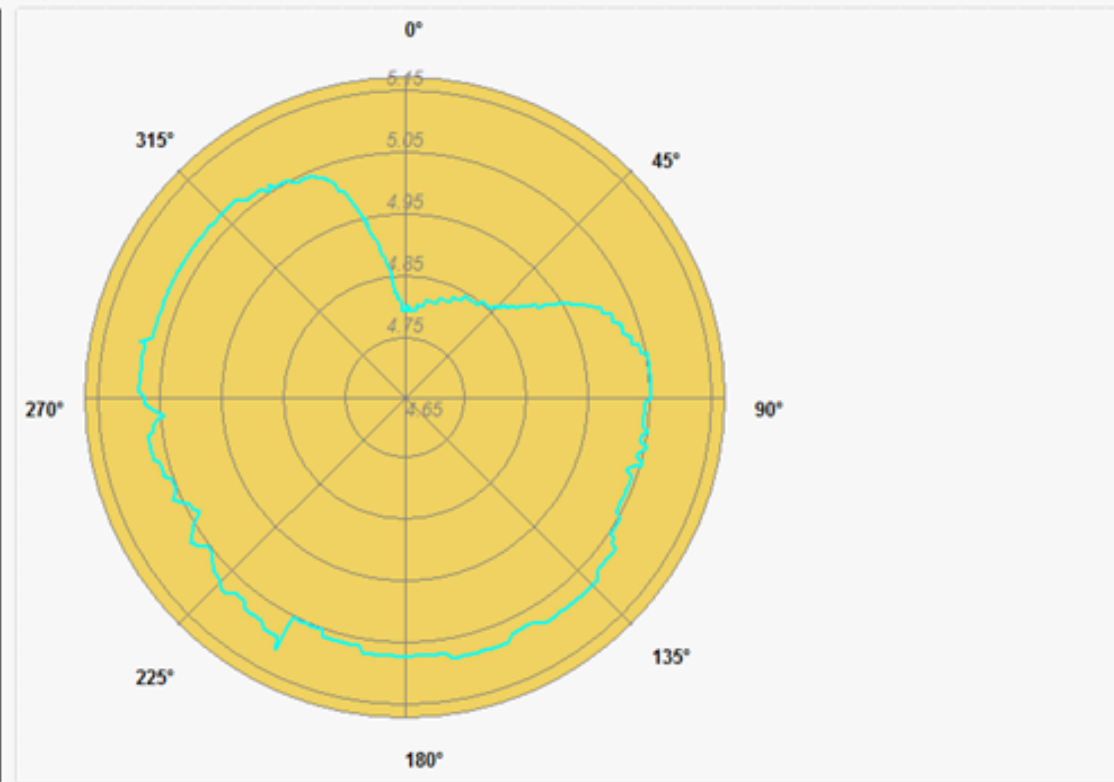
Sauver JPG

Rotation

Trajet en rotation : Fréquence en fonction de l'angle



Trajet en rotation : Graphique polaire



Fréquence absolue mesurée en Hz

 $1/(F \cdot F)$ Centre = $1/(F_0 \cdot F_0)$

Numéro de rotation

1 / 7

Diam (mm)

140.00

Abscisse en translation (m)

0.72

Rotation (deg)

Précédente rotation F7

+

Rotation suivante F8

Capa (pF)

0.00

f (Hz)

0

GO Entrée

EVE F3

Now

Echelle F4

Info F5

Visu Rot/lin F6

Sortir F12



NATIONAL BRIDGE PRESERVATION PARTNERSHIP CONFERENCE 2018

PRACTICES WE CAN NOT AFFORD TO DEFER

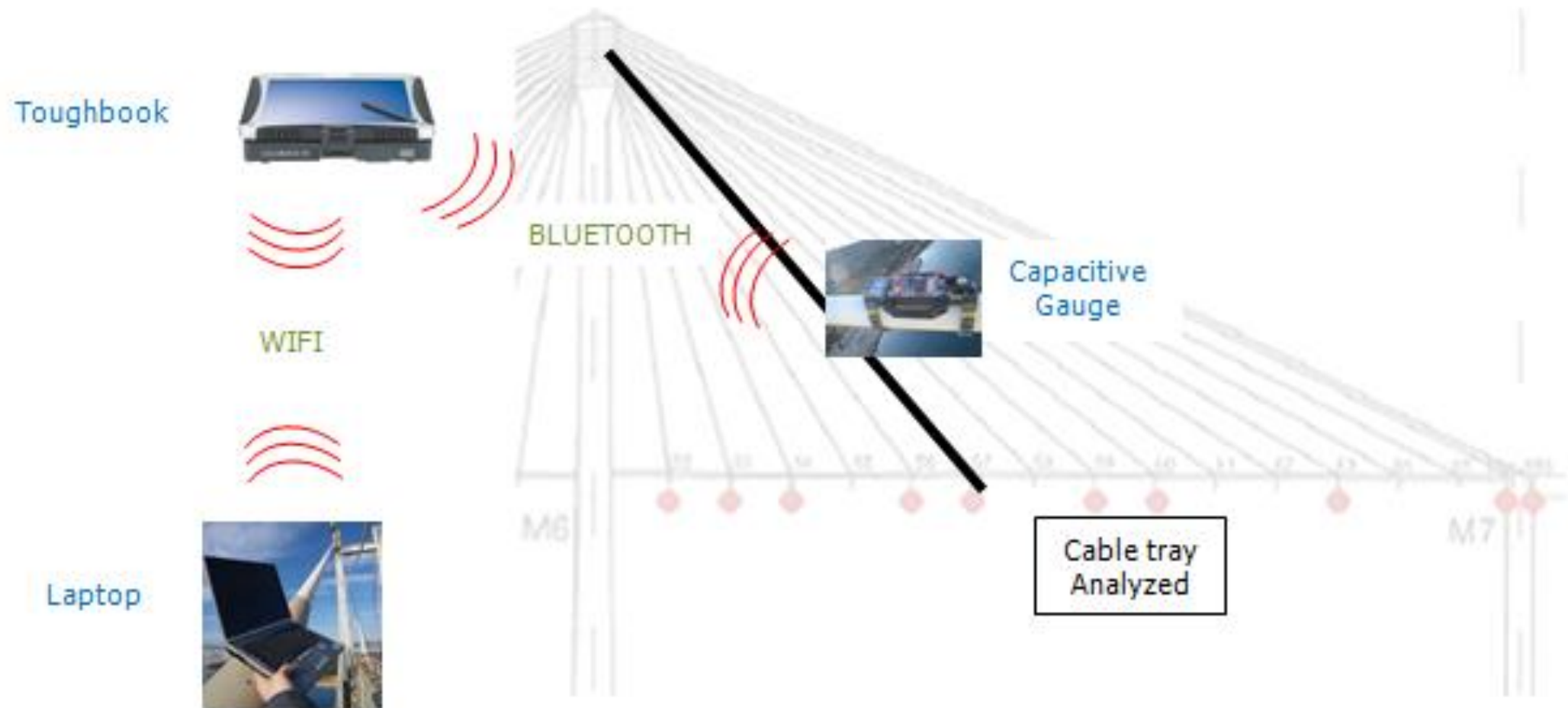
Field Use And Evaluation

Testing

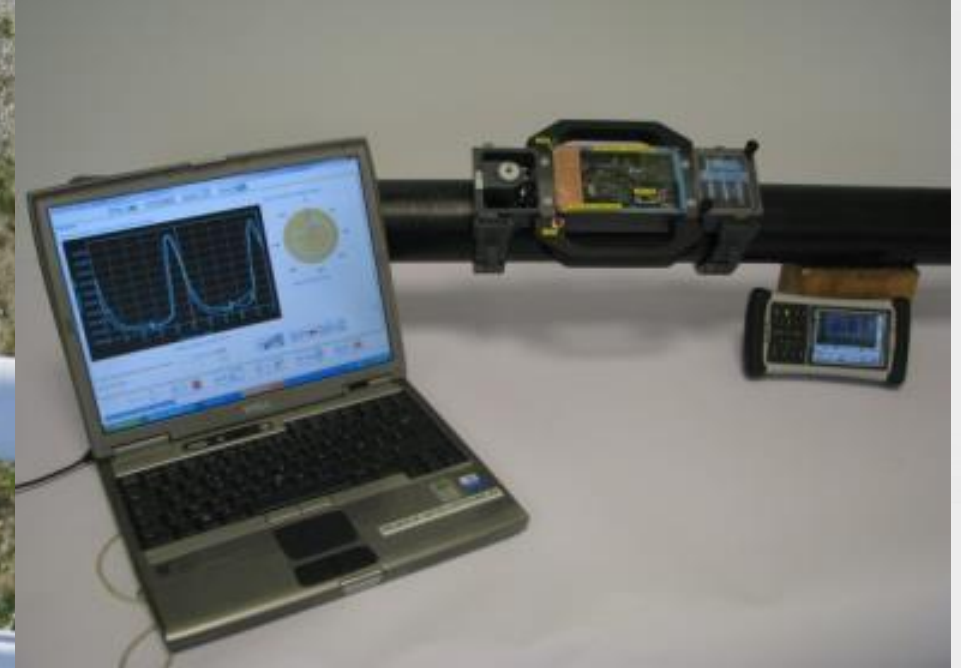
1. Clean or wipe the duct surface (e.g. dried burrs of grout with a painter's knife) to allow for passage of the sensor
2. Turn the sensor on and get a baseline reading of the ambient air temperature
3. Place the sensor on the pipe and attach the two straps/collars to hold it in place
4. Open the PC program and enter relevant information about pipe diameter, tester name, notes, etc.
5. Move the sensor along the duct and obtain measurements in real time



Communication on site

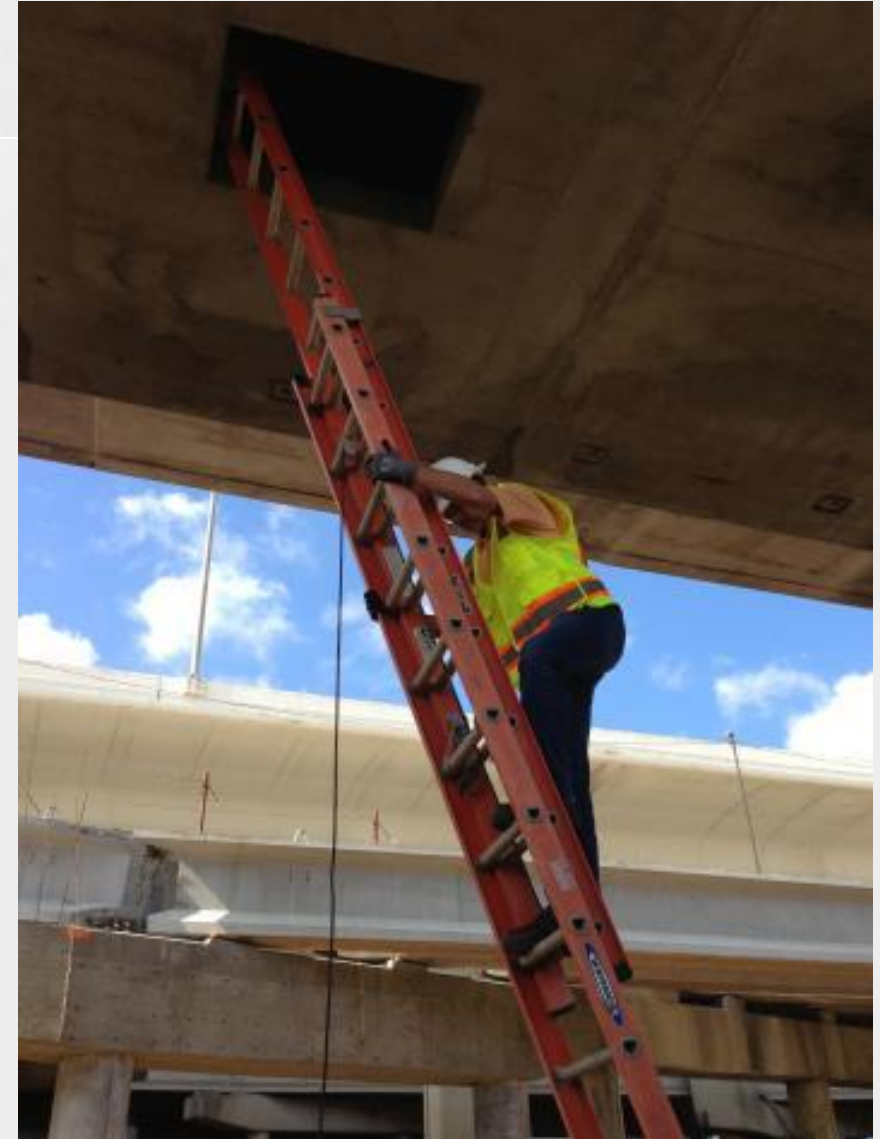


On Site – Cable Stay bridge





On Site – Box girder





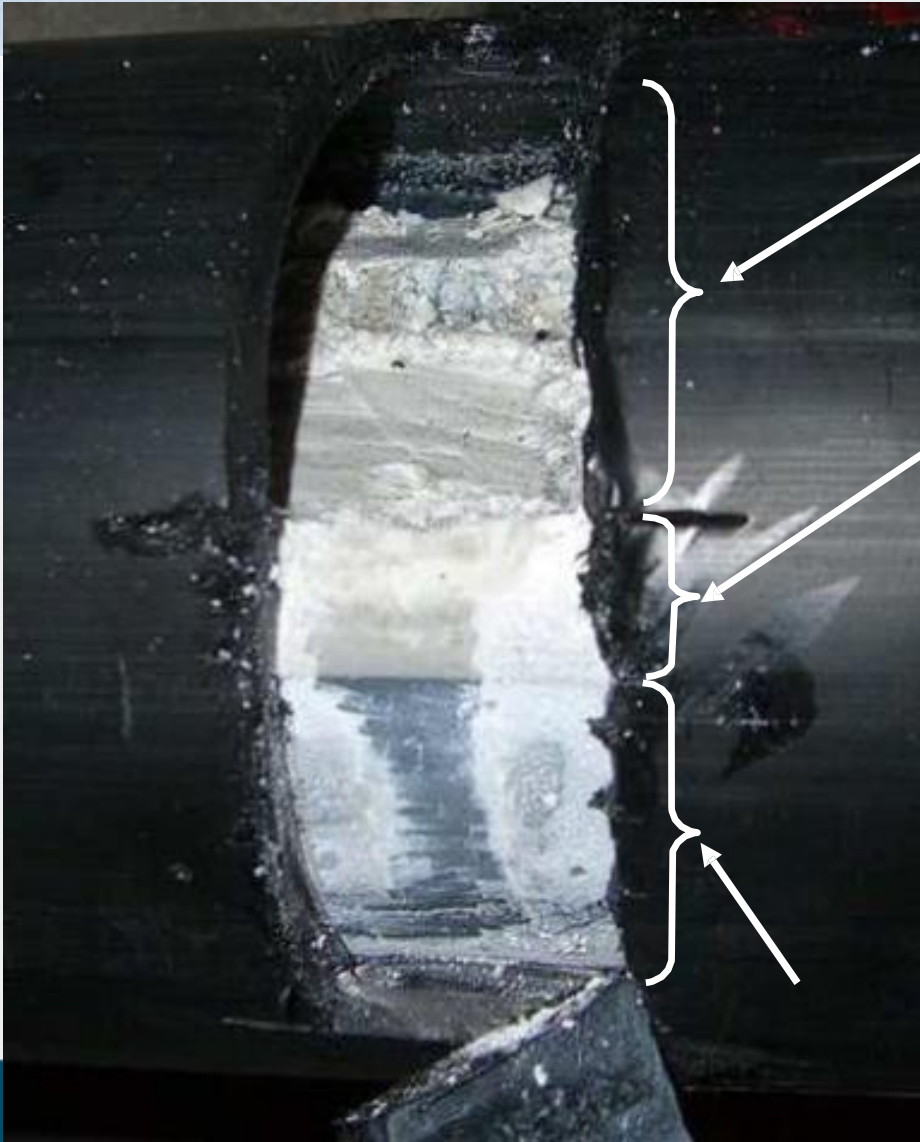
In the Field - France



Labéraudie Viaduct



Open ducts and Verification on Site



AL BR



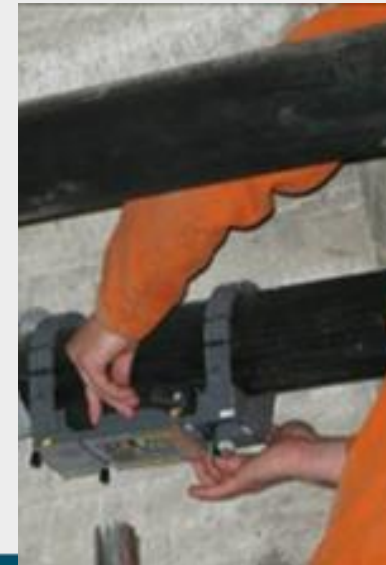
Examples of white paste

Examples of voids



Efficiency

- Test approximately 1350 linear feet per day (400m/day), depending on:
 - Access conditions
 - Clean required on the ducts
 - Free length of the duct
 - Number of full 360 rotations needed



Real-Time visualization with Software



Imprimer

Conclusion essai

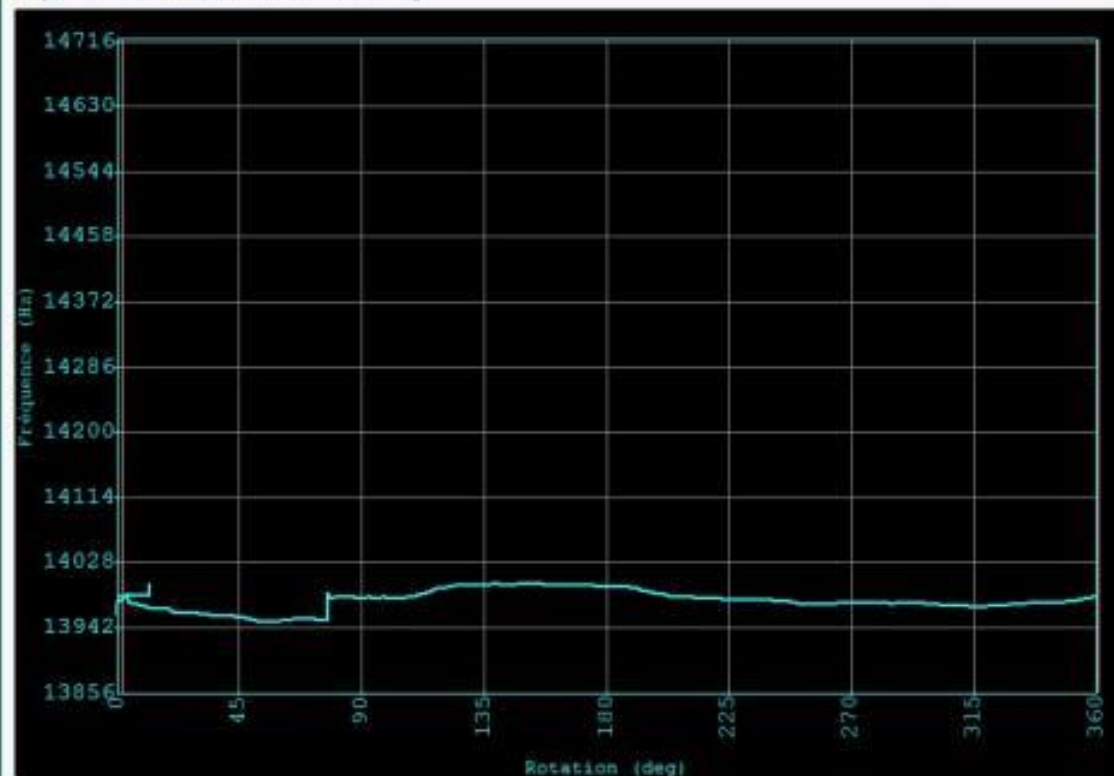
Conclusion session

Annexes

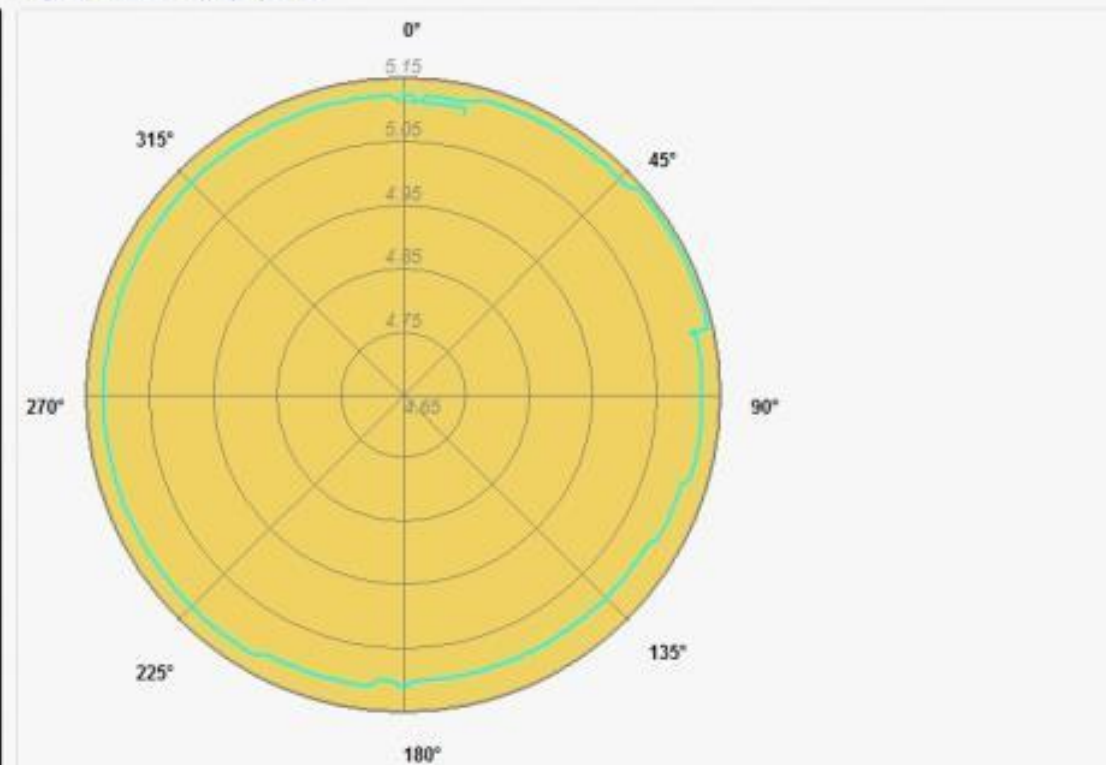
Sauver JPG

Rotation

Trajet en rotation : Fréquence en fonction de l'angle



Trajet en rotation : Graphique polaire



Fréquence absolue mesurée en Hz

 $1/(F \cdot F)$ Centre = $1/(F_0 \cdot F_0)$

Numéro de rotation

1 / 1

Diam (mm)

110.00

Abscisse en translation (m)

0.48

Rotation (deg)

372.3

Capa (pF)

5.10

f (Hz)

13999

Précédente rotation F7

+

Rotation suivante F8

FIN

EVE F3

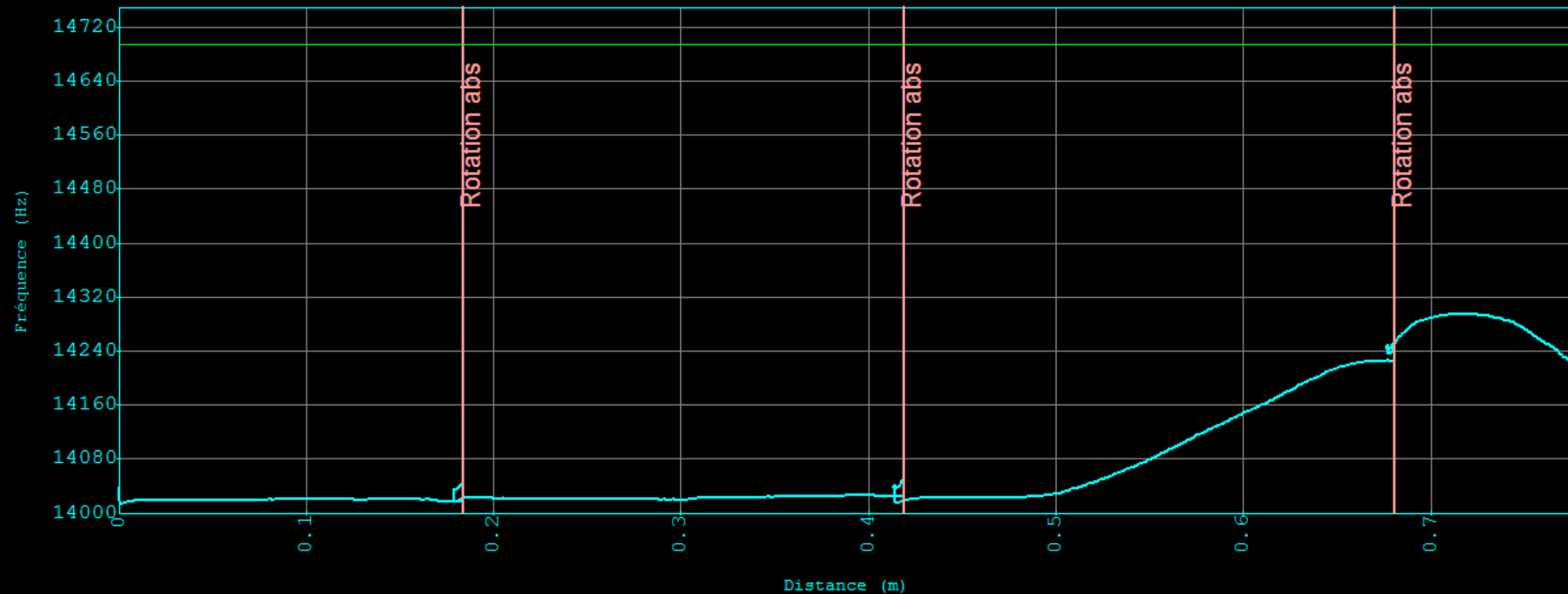
Echelle F4

Info F5

Vau Rot/lin F6

Sortir F12

N° 520 F=13999Hz Capacité =5.1 pF Distance=0.48m R=372.3deg F0=14670Hz



Fréquence absolue mesurée en Hz

Distance (m)

Rotation (deg)

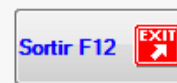
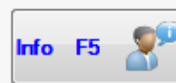
Tension

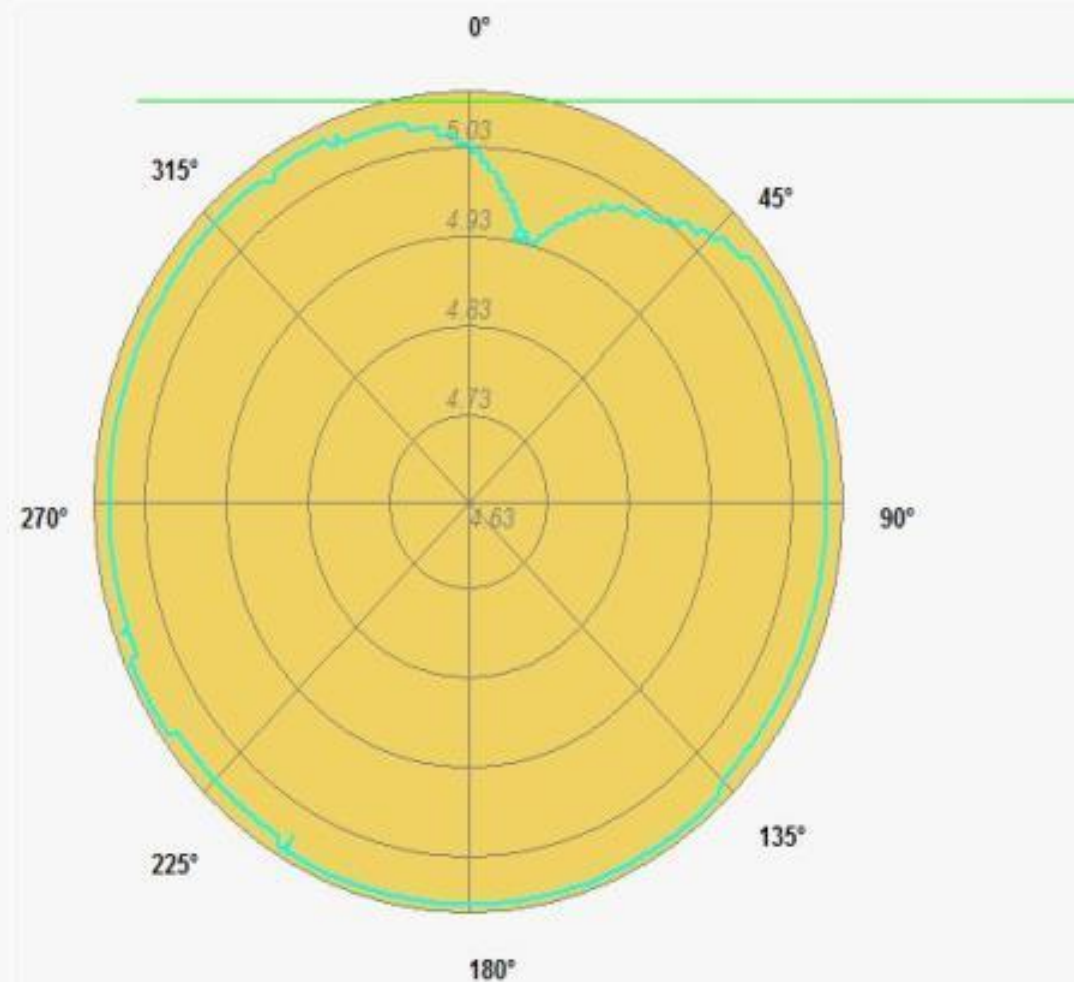
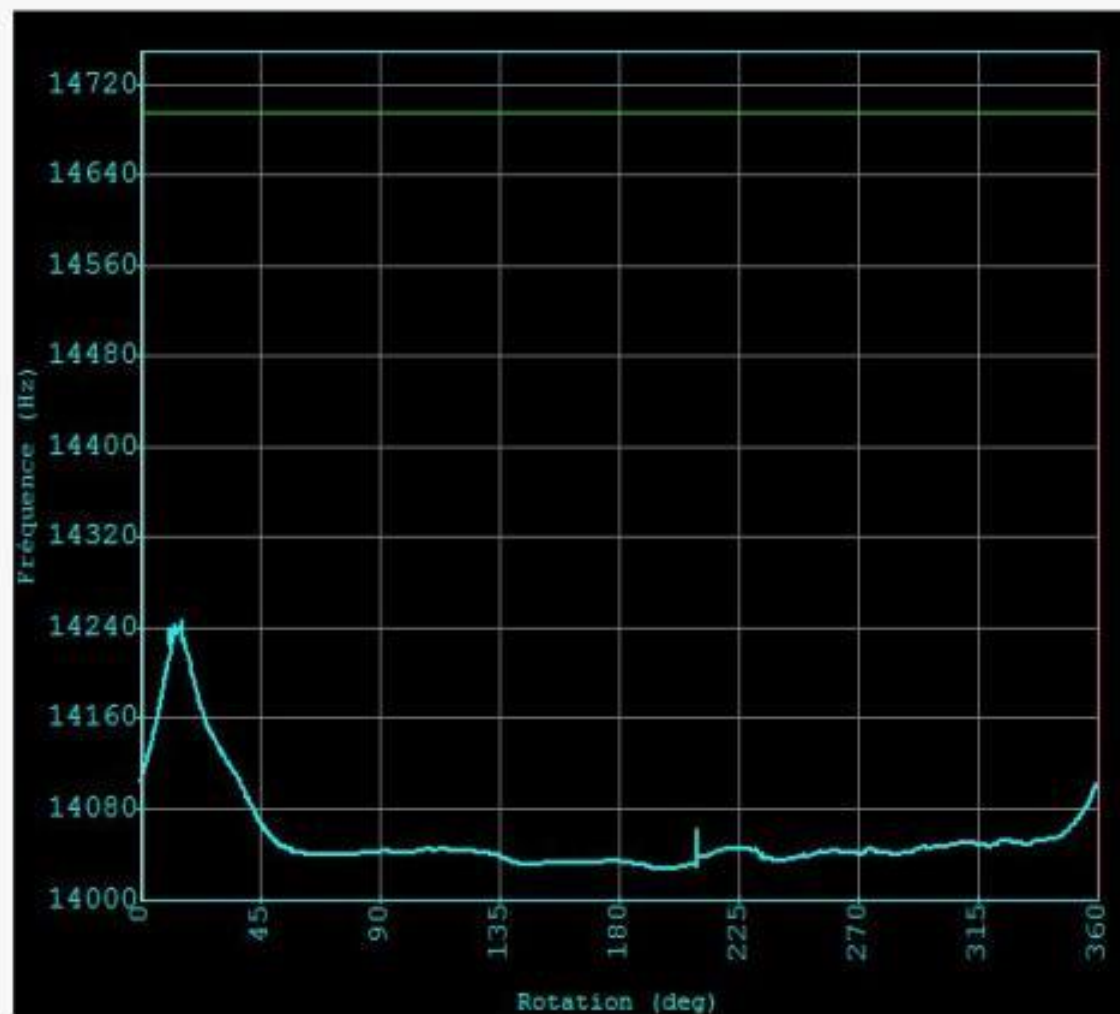
f (Hz)

0

 $1/(F \cdot F)$

0.00





3CP PC — C:\Users\sschorn\Documents\Company Info\EScan\EScan Application\3CP\3CP_Sauvegarde_Image\20130614\Fully Grouted with void test 3_sai_138_rot.jpg 1/(F*F) Centre = 1/(F0*F0) Num rot =3 rot Distance = 0.681 m



NATIONAL BRIDGE PRESERVATION PARTNERSHIP CONFERENCE 2018

PRACTICES WE CAN NOT AFFORD TO DEFER

Project Example

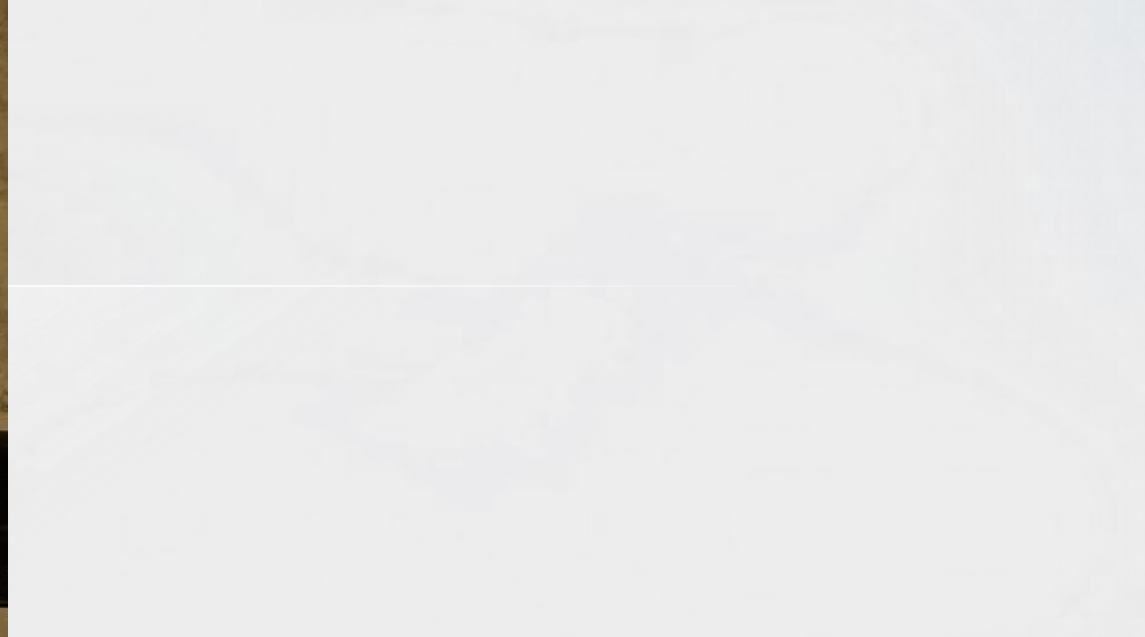
- September to December 2017
- 434 tendons inspected
- West bridge
 - 88 sections with significant defects
 - 151 sections with probable defects (small voids)
 - 17 tendons with no defects
- East Bridge
 - 60 sections with significant defects
 - 163 sections with probably defects (small voids)
 - 22 tendons with no defects













S-11B-14-145

SS







What do I get?

What do I Get?

- Accurate localization of voids/white paste
- Estimate of void cross section
- Cost effective local repair before tendon failure



NATIONAL BRIDGE PRESERVATION P

PRACTICES

Advantages

- Unique – NDT that can detect soft grout
- Sensitive
- Reliable
- Developed and validated by IFSTTAR (LCPC)
- Fast
 - Dozens of linear feet a day
- Use on External PT, Stay Cables
- Limitation: free length of ducts

Conclusion

- Escan can identify materials inside external PT ducts
- Simulations and testing have established the sensitivity and accuracy of Escan
- Agreement between experimental measurements and Finite Element simulations
- Verification in the field
- Quick method for determining locations for other, pointed inspections