CELEBRATING 175 YEARS 1835-2010

ENGINEERS IRELAND

cpd APPROVED EVENT

4th Transnational Workshop duratiNET

duratiNet

DURATI NET project presentation to UK and Irish end users

June 11th 2010

Innovation Academy, Trinity College of Dublin, Ireland

Steel maintenance and repair

by F. Schoefs

Institute for Research in Civil and Mechnical Engineering (GeM)

University of Nantes, France

European Union

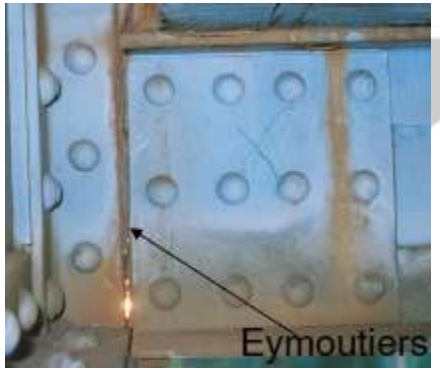
European Regional Development Fund

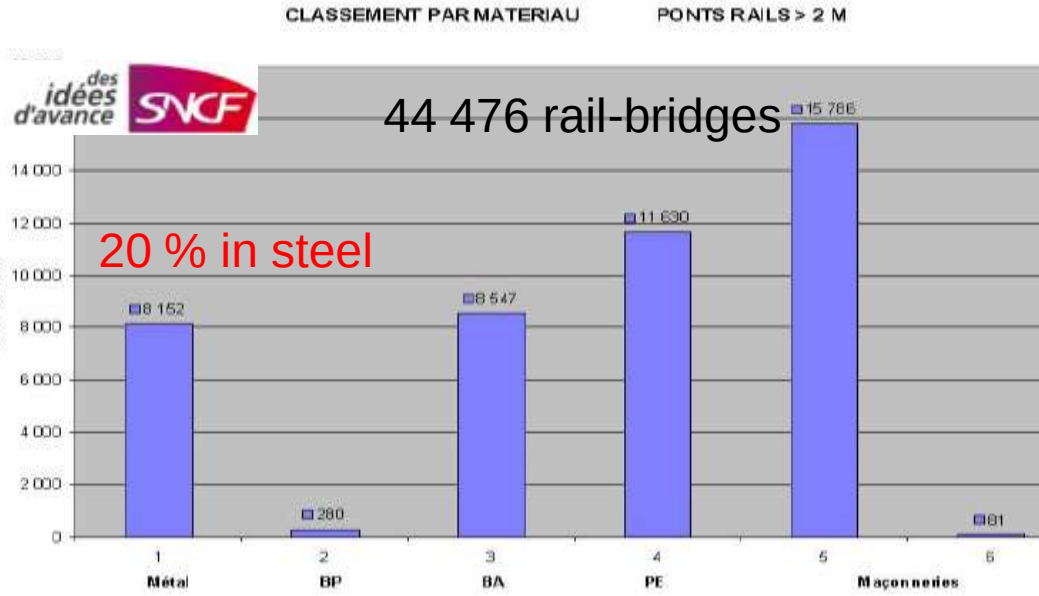
Investing in our common future

ATLANTIC AREA Transnational Programme

Stakes and Considered Ageing Mechanisms:

- Damaging (Fatigue)





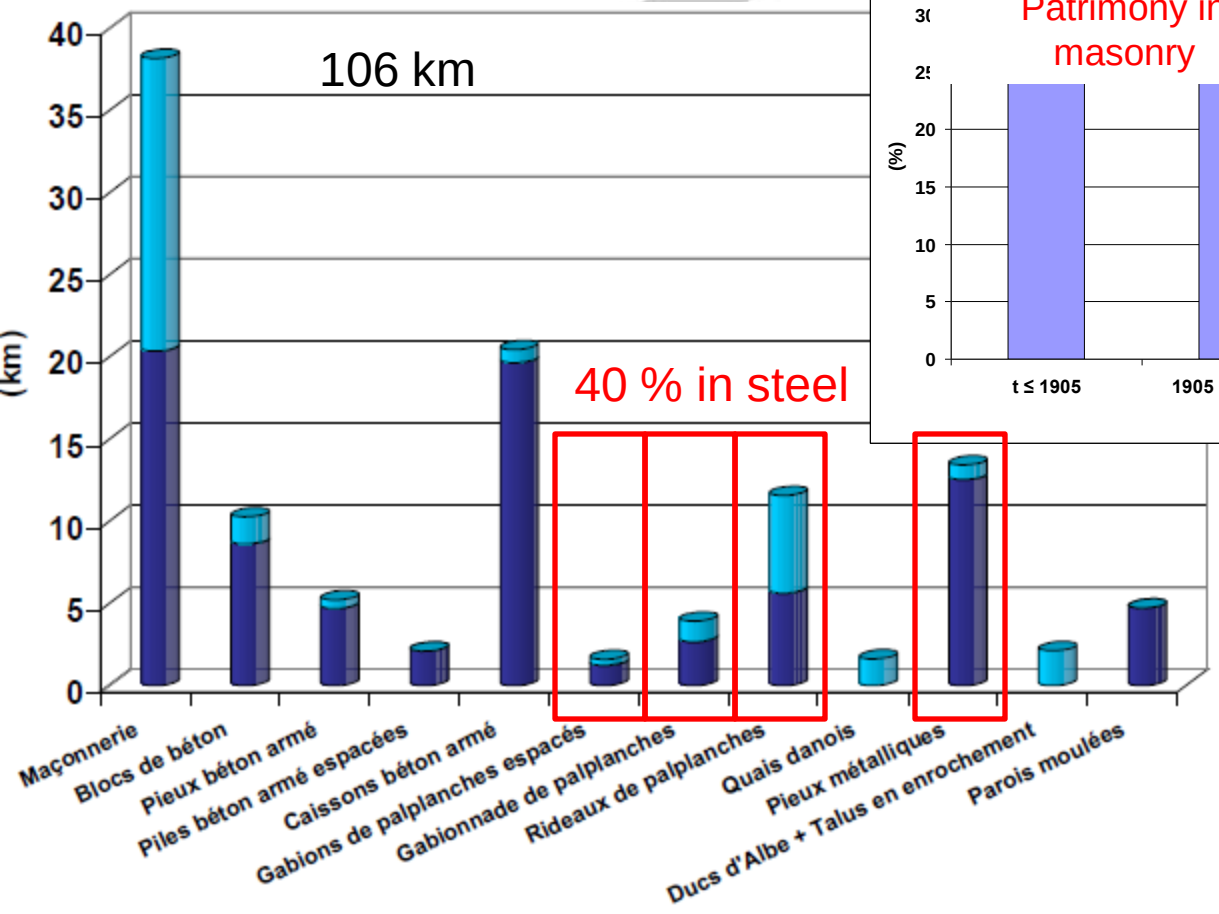
- Corrosion - (main cause)

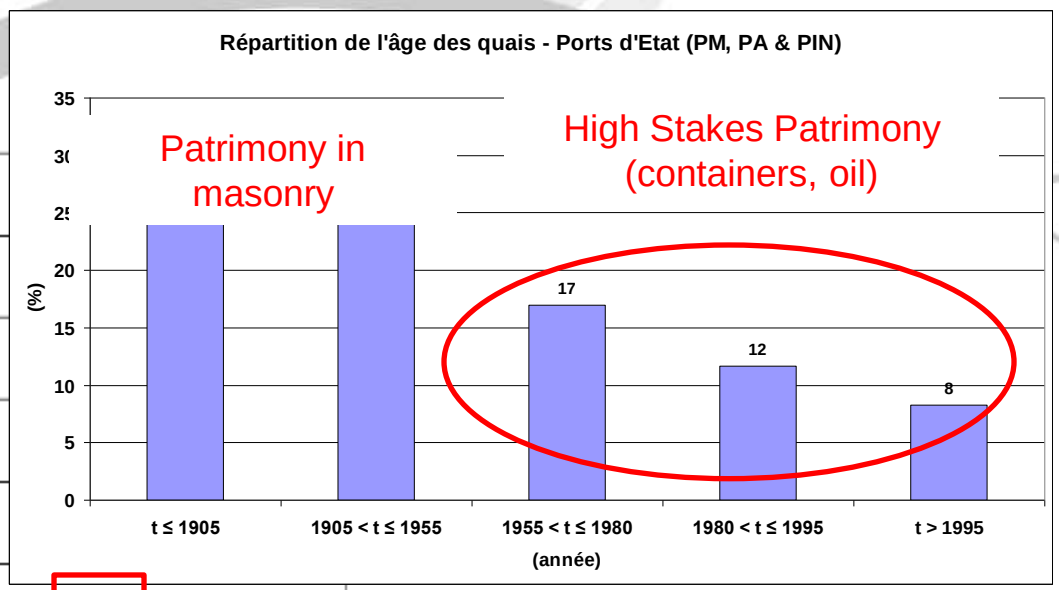
CORROSION feuilletante

CORROSION CREUSANTE

1/3 more than 100 years old

Stakes and Considered Ageing Mechanisms:





Project GEROM – Oxand

MR-GenCi

Case of suspension-bridges : why ?

The corrosion process in cables is very hard to model

because :

- It is affected by a lot of time-variant and space-dependent factors : Temperature, Wind, Humidity.
- The number of fibers in cables is huge.
- On-site measurements are costly and difficult to realize.

→ Need to gather data in a well documented data base and quantify the performance of NDT-tools. Include existing models (Yotte et al.) in a maintenance flow-chart.

Case of metallic (rail-)bridges : why ?

The fatigue process in beams is very hard to model / the structural modelling is feasible.

Real challenges:

- Increasing the use of rail for european transport: up-dated reliability target ?
- Inspection of cracks is difficult (see ICON / MITKI projects).

→ Need to gather data in a well documented data base.

Case of habour structures : why ?

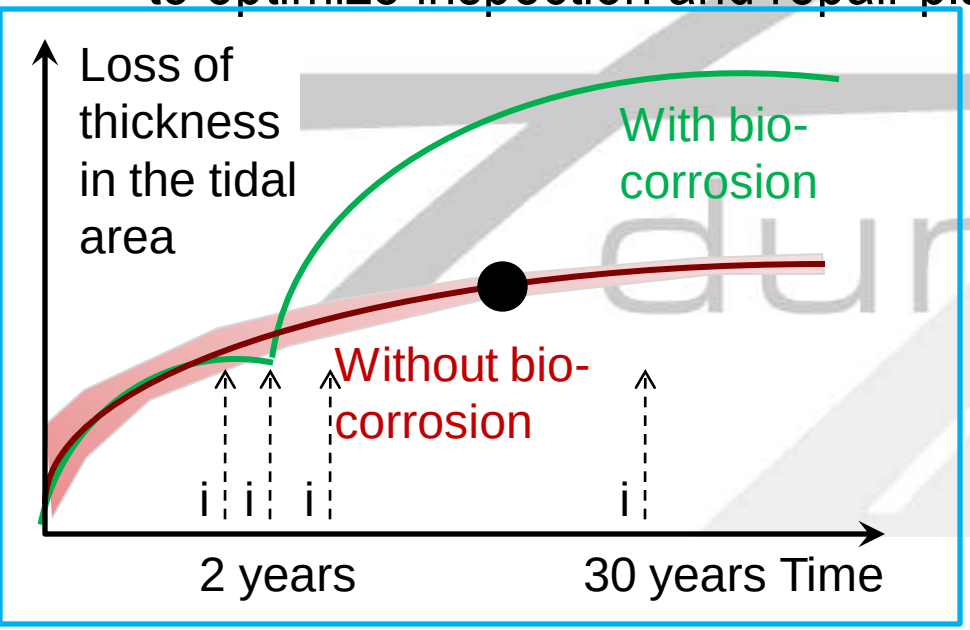
The corrosion process is very hard to model because :

- It is affected by a lot of time-variant and space-dependent factors : Temperature, Dissolved Oxygen, Salinity, Tide level, Suspended materials (bio-corrosion), pollution, water flow/waves, abrasive materials.
- Only few on-site measurements are available and not always well documented (context).
- On-site measurements are costly and difficult to realize.

→ Need to gather data in a well documented data base

Why ageing models are required ?

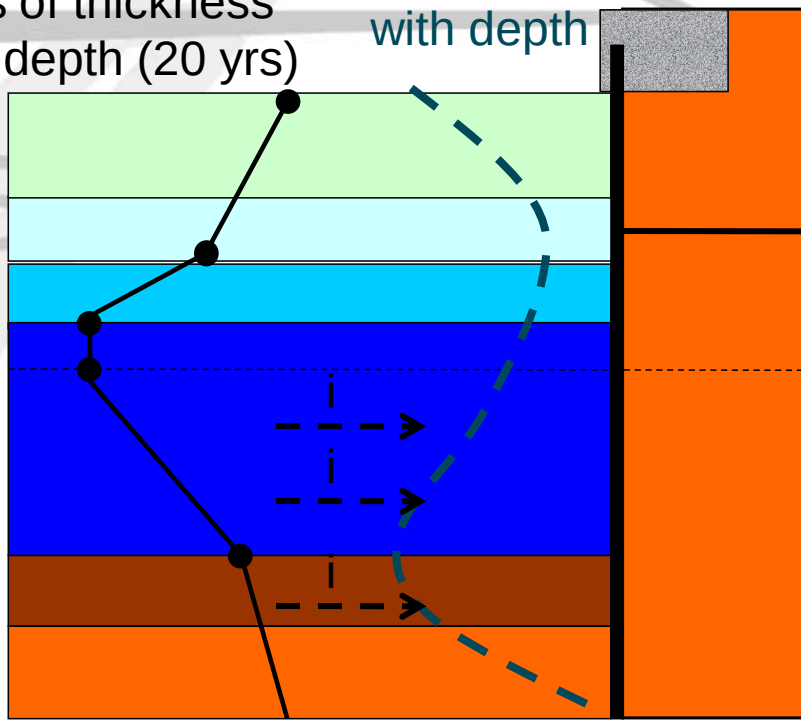
- to optimize inspection and repair planning **with time**.



But difficult to inspect : what it seen ?

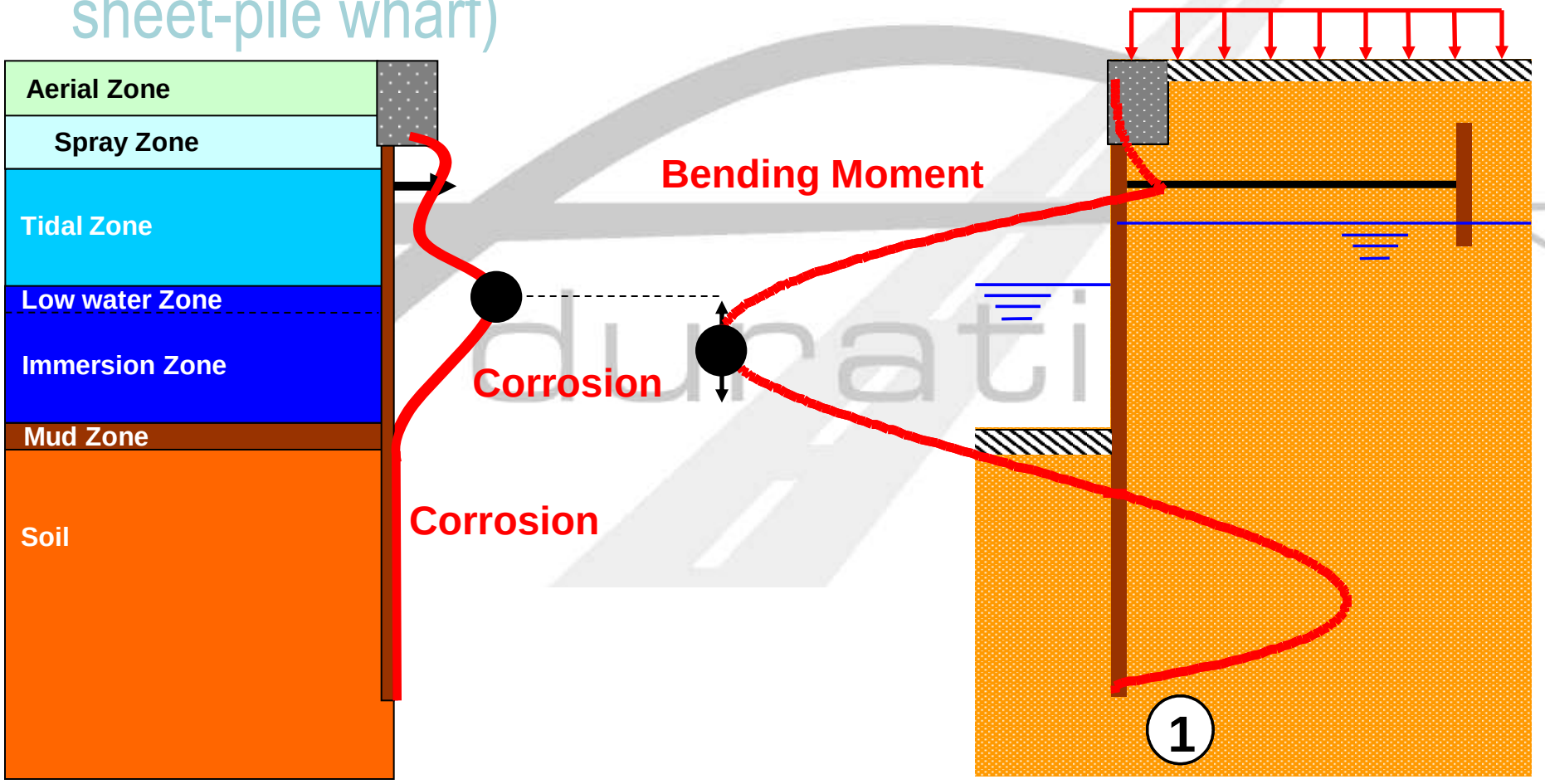
Loss of thickness with depth (20 yrs)

Bending moment with depth



- to optimize inspection and repair planning **with space**.

Effect of corrosion on mechanical behavior (case of a sheet-pile wharf)

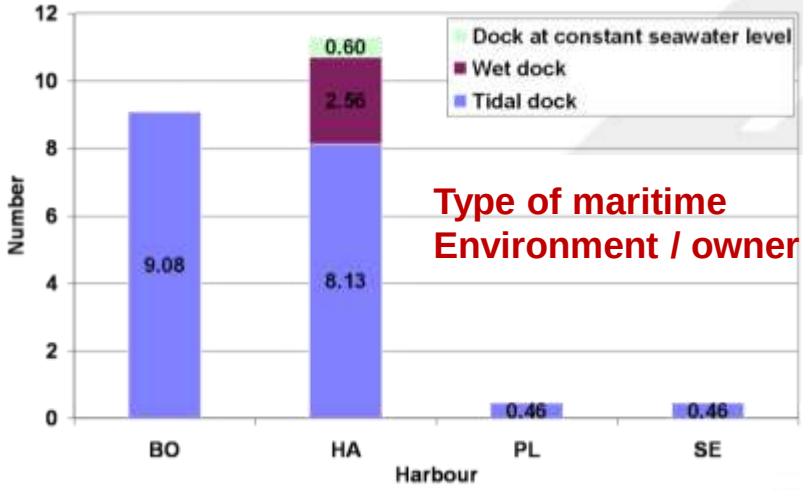


French experience

- Guidelines are published by the government (not rules), but too expensive ← feedback of owners
- Data are available

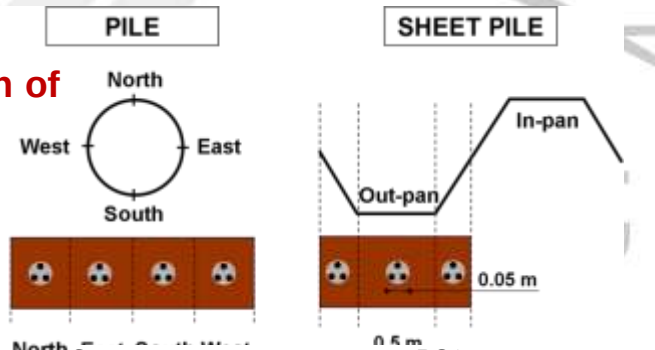
(100 000 measurements)

- The data base is now documented



Type of maritime Environment / owner

Nb and location of measurements



Chemical characteristics

Structure	BO1 HA7d & HA8b				
Parameter	Mean	Min	Max	Mean	Min	Max
Temperature (°C)	13.3	7.2	19.5	13.7		8.1
	20.7					
pH	8.0	7.8	8.1	8.1		7.7
	8.5					
Conductivity (mS/cm)	49.0			46.8	50.5	
	37.2	33.7	41.4			
Salinity (g/l)	32.9			31.5	33.7	
	25.4	23.9	27.7			
O2 (mg/l)	8.7			6.4		
	11.2	8.7		6.9	11.0	
SM* (mg/l)	9.9			4.7	17.7	
	8.3	3.3	15.0			

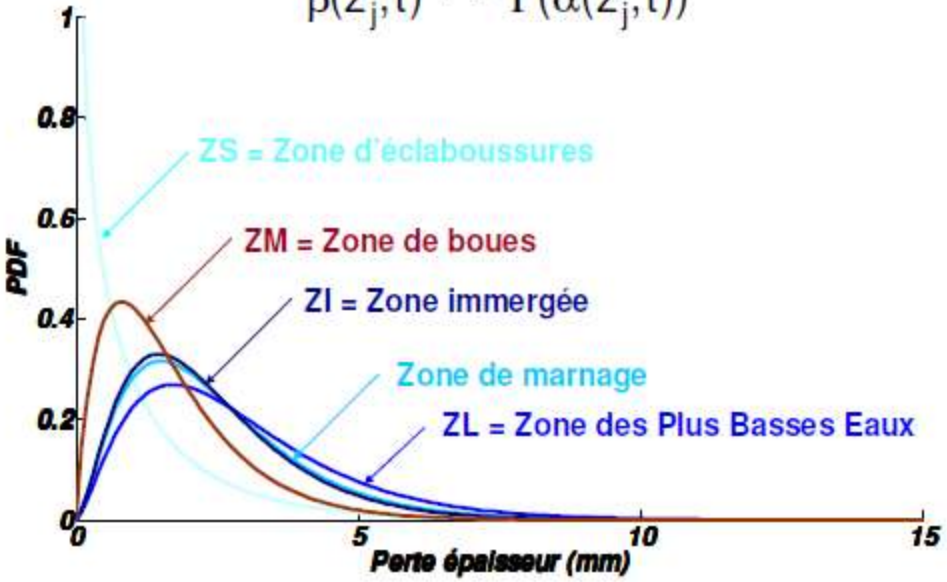
ATLANTIC AREA Transnational Programme

French experience

- Model are emerging (Gerom projects with Oxand SA)

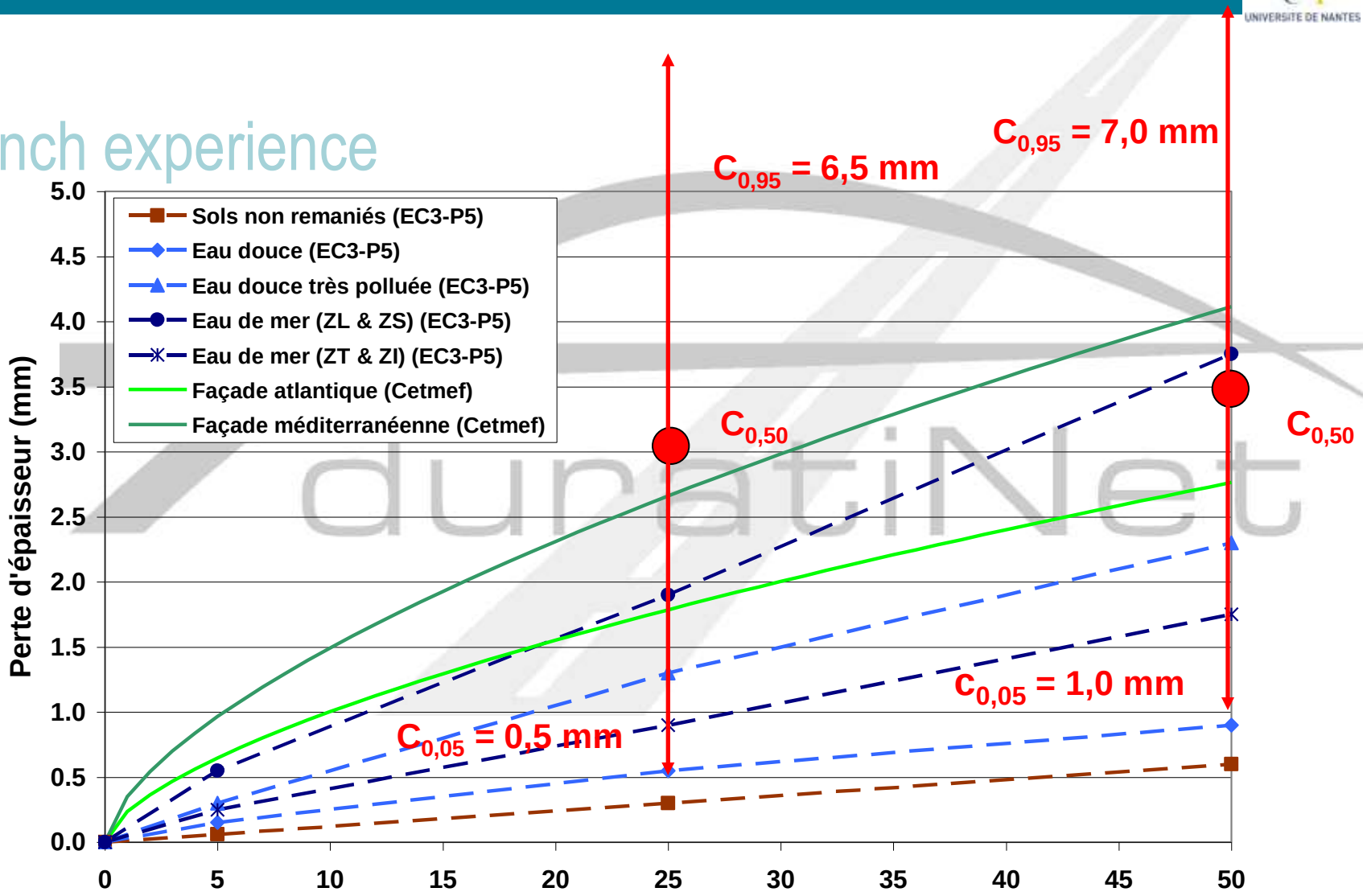
Loi de probabilité Gamma de paramètres α et β :

$$f_C(c, z_j, t \mid \alpha, \beta) = \frac{1}{\beta(z_j,t)^{\alpha(z_j,t)}\Gamma(\alpha(z_j,t))} c^{\alpha(z_j,t)-1} \exp^{\frac{c}{\beta(z_j,t)}}$$



Distributions de la perte d'épaisseur d'acier au temps t = 25 ans

French experience

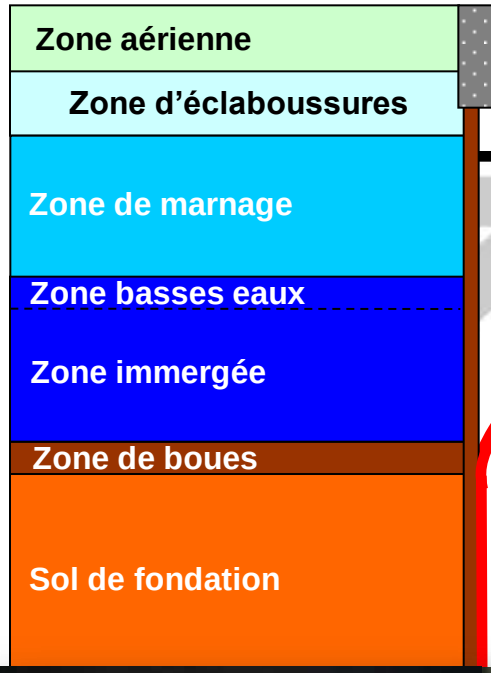


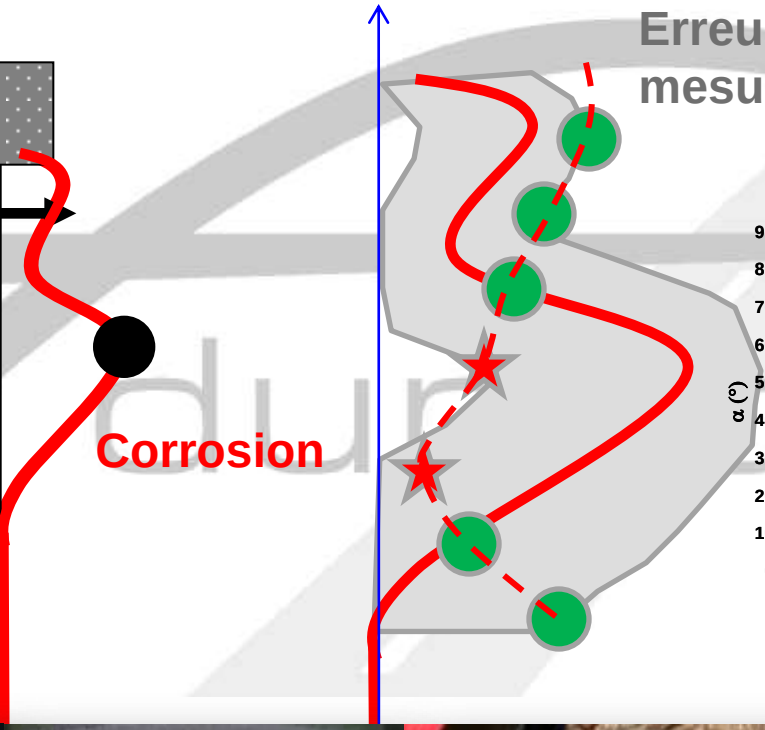
Comparaison avec les préconisations des règlements de calculs

Surépaisseurs sacrificielles d'acier en fonction de la durée de service d'un ouvrage pour une seule face exposée d'après l'Eurocode 3 et le CETMEF

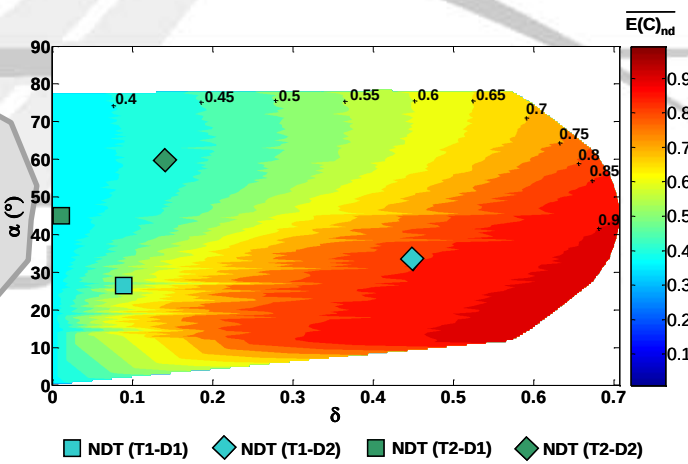
La problématique de l'inspection …

… en quelques mots





Erreur de mesure = f(z)



To be made : objectives of Duratinet

- Share Practices and data in the Atlantic area
- Provide guide-lines based on risk analysis in view to optimize the number of measurements at each inspection time and the number of inspections (in link with WG2)

Complete the knowledge : specimens on site (documented)

Mapping of corrosion (Gabion type)

Corrosion rate

Data analysis (residual thickness – ROC)

To be made : objectives of Duratinet

- Share Practices and data in the Atlantic area
- Provide guide-lines based on risk analysis in view to optimize the number of measurements at each inspection time and the number of inspections
- Provide guide-lines based on risk analysis for the maintenance (painting) **NEW** : feedback is essential (if documented) : environmental conditions during painting works / type of product ...

Results of Medachs project

- rank 5 main coating products performance

------- : Bad

------- : Medium

------- : Good

Zinc polyurethane Mono-component + mixed resin « polyurethane + hydrocarbon »

Epoxy-polyamide or polyester coating + flakeglass

Epoxy coating

Limit States D(d(xi)) < 0

Fixing (4 months)	Paint 1	Paint 2	Paint 3	Paint 4	Paint 5
Visual aspect (10 months)	Paint 1	Paint 2	Paint 3	Paint 4	Paint 5
Porosity (10 months)	Paint 1	Paint 2	Paint 3	Paint 4	Paint 5

Pb : head of pile

To be made : objectives of Duratinet

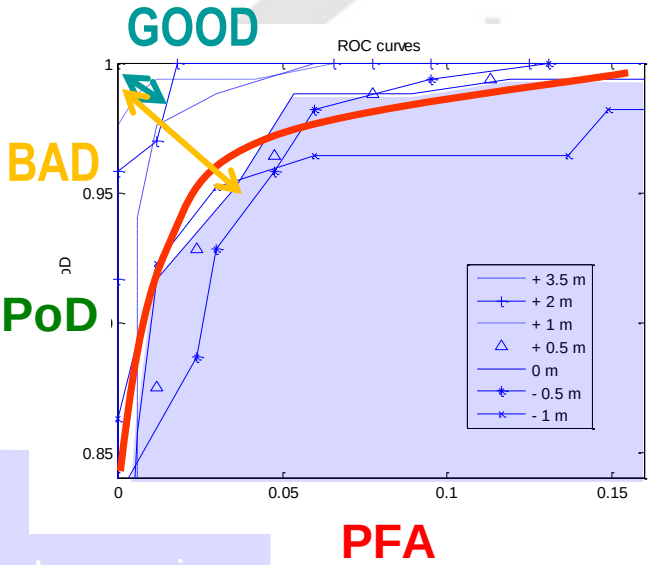
- Share Practices and data in the Atlantic area
- Provide guide-lines based on risk analysis in view to optimize the number of measurement at each inspection and the number of inspection
- Provide guide-lines based on risk analysis for the maintenance (painting) NEW : feedback is essential (documented) : environmental conditions during painting works / type of product ...
- Provide data base for measurement of NDT tool performance on site. Developp the use of connex data : video-tapes before painting. **NEW**

Results of Medachs project

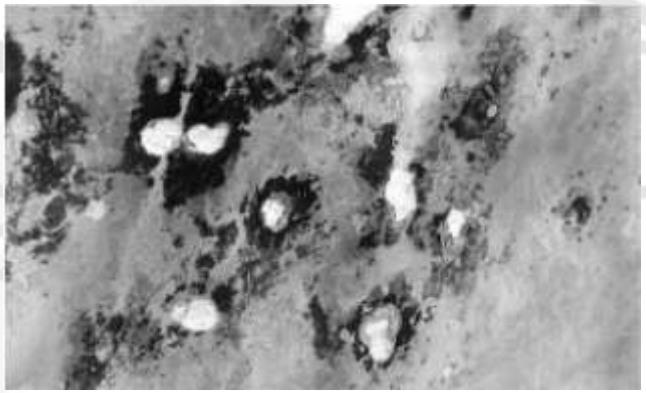
Uniform corrosion (from data in Brest, Nantes, Boulogne)

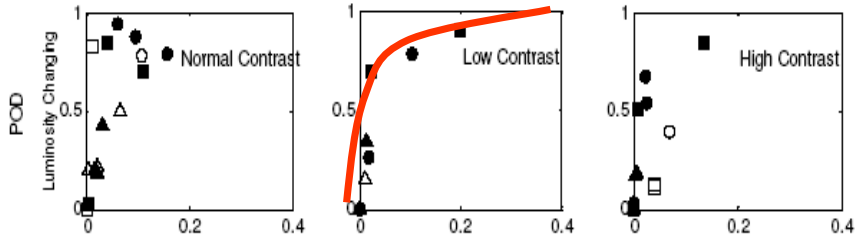
Immersion Area

ROC plot (thickness)



Localized corrosion Theoretical work





ROC plot (area, maximum axis)

To be made : objectives of Duratinet

The ESSENTIAL role of end-users :

- Maintenance policy (repair during winter for touristic equipments)
- Feedack about products/protocols (complicated or not)
- Benchmark structures with real stakes.

Thank you !