6th Transnational Workshop duratiNET

DURATI NET project presentation to French end users

June 7th 2011

Innovation Academy, Trinity College of Dublin, Ireland

Steel maintenance and repair

by F. Schoefs

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LUNAM Université, University of Nantes, France

European Union

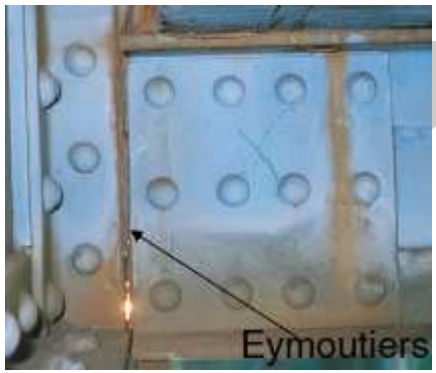
European Regional Development Fund

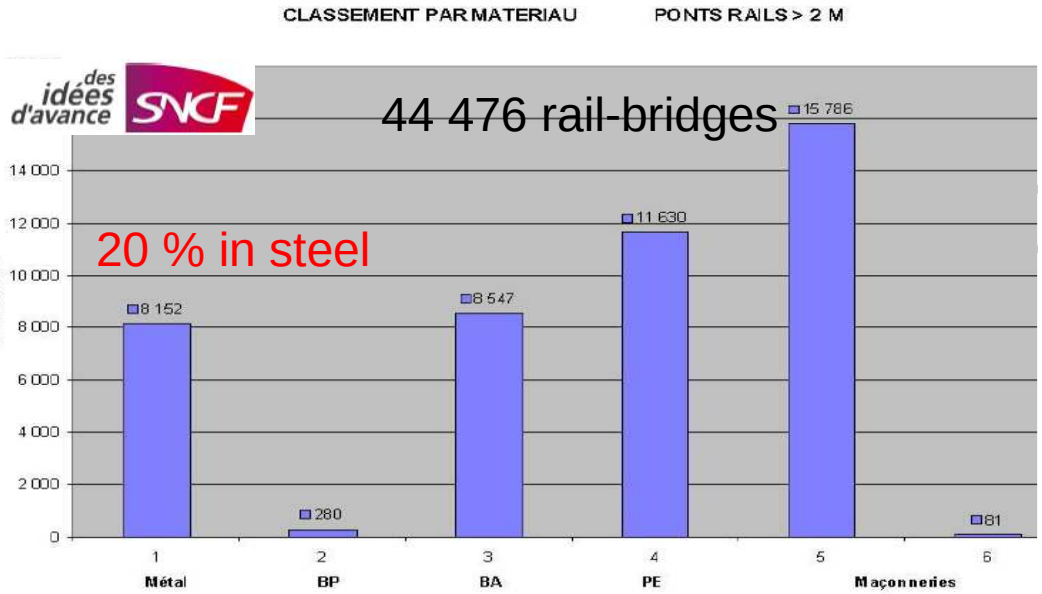
Investing in our common future

ATLANTIC AREA Transnational Programme

Stakes and Considered Ageing Mechanisms:

- Damaging (Fatigue)





- Corrosion - (main cause)

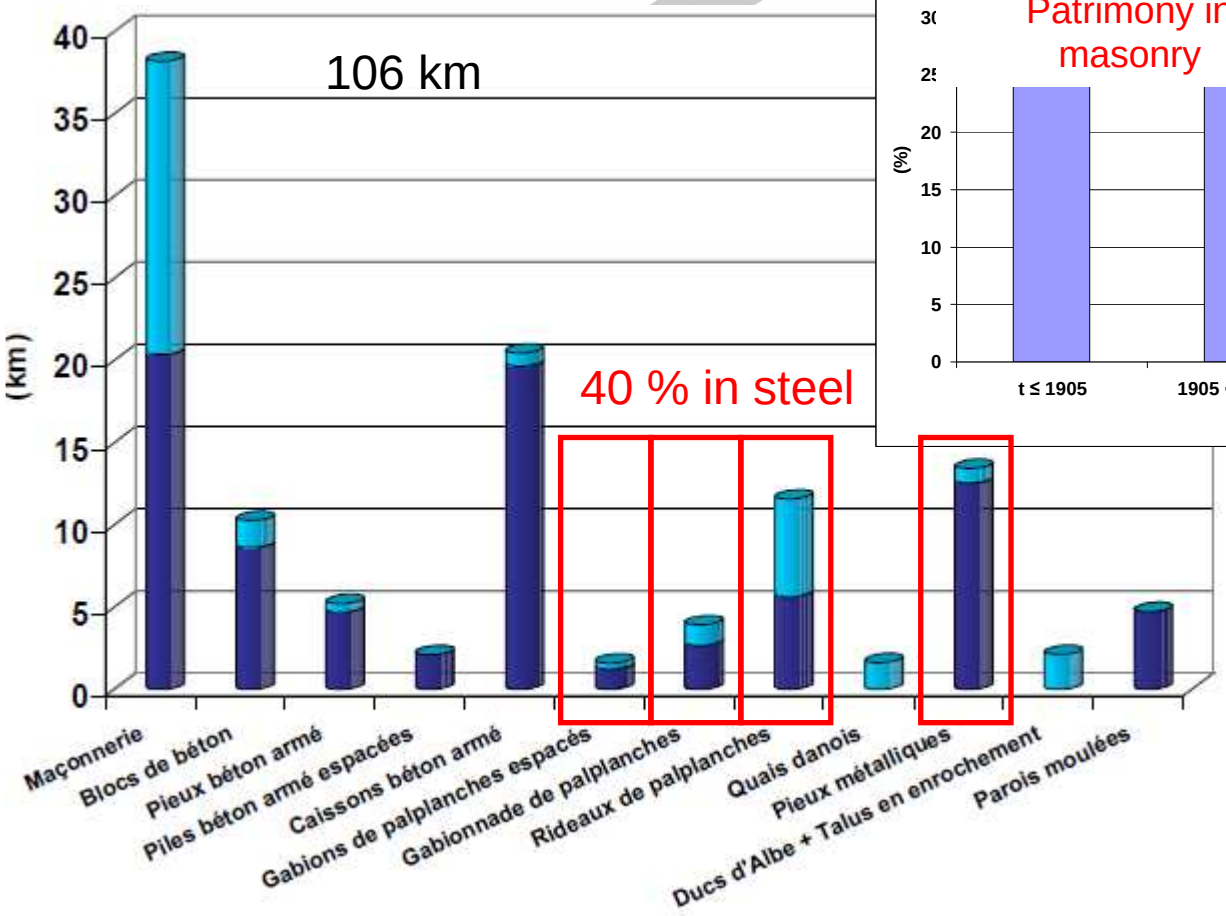
CORROSION feuilletante

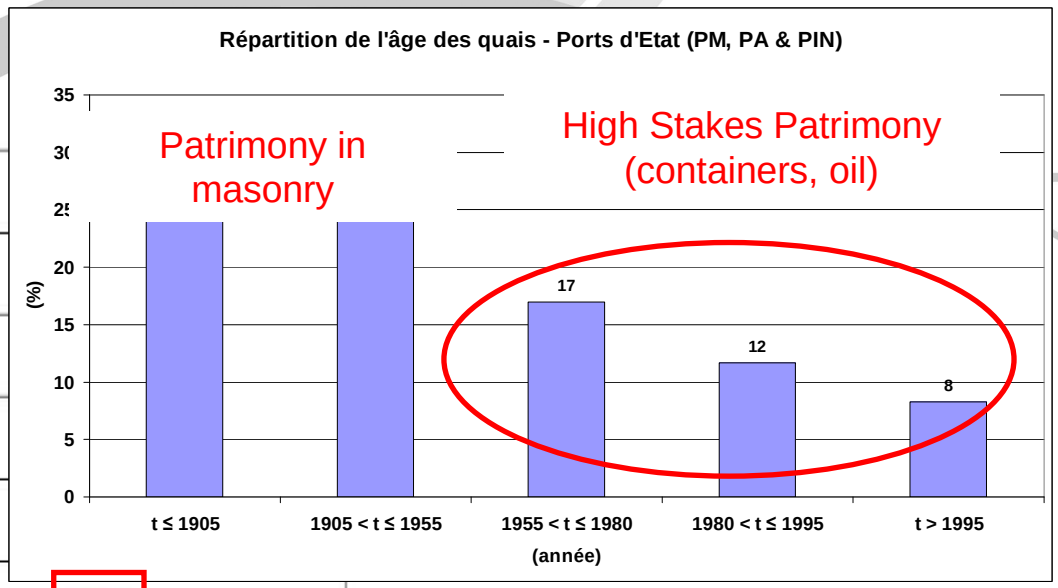
CORROSION CREUSANTE

1/3 more than 100 years old

2 % of steel bridges (rail+road) in Ireland

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 ?

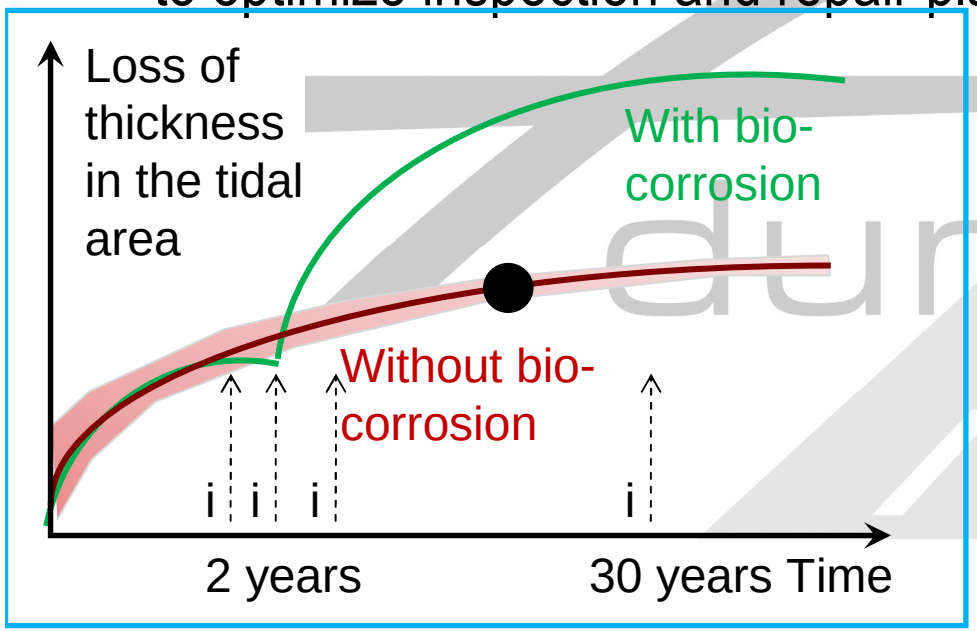
The corrosion process is very hard to model because :

- 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 ?

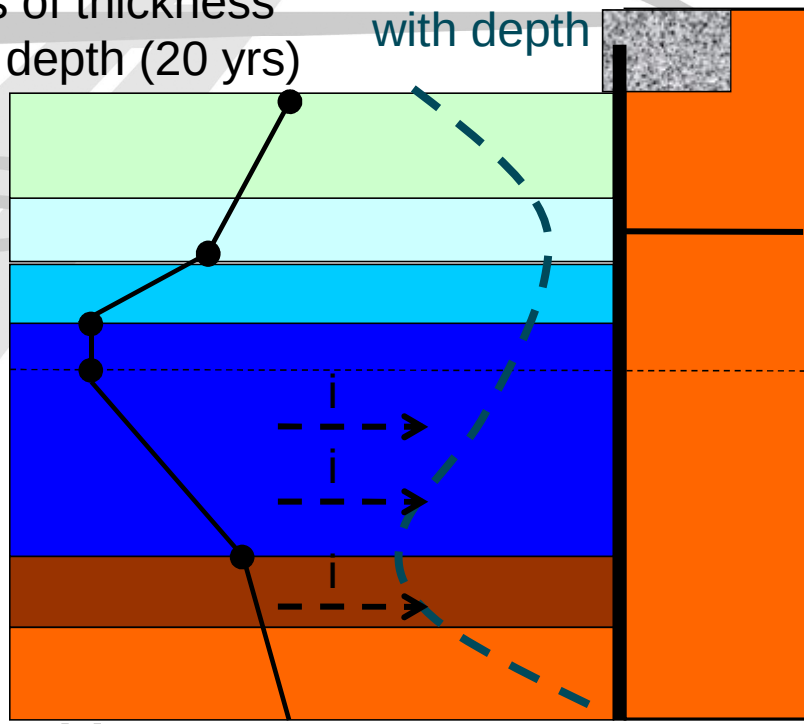
- to optimize inspection and repair planning **with time**.



But difficult to inspect : what it seen ?

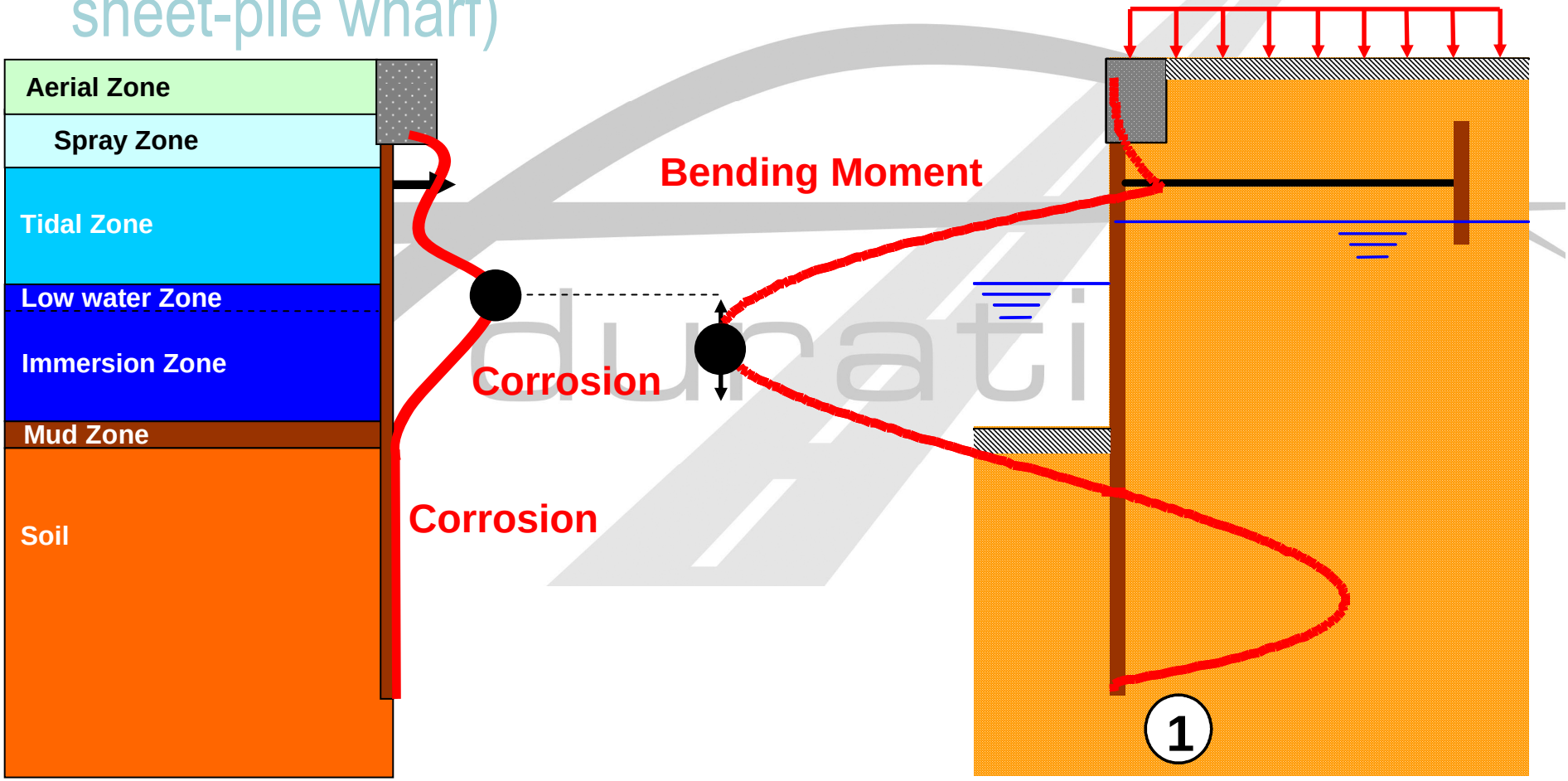
Loss of thickness with depth (20 yrs)

Bending moment with depth



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

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

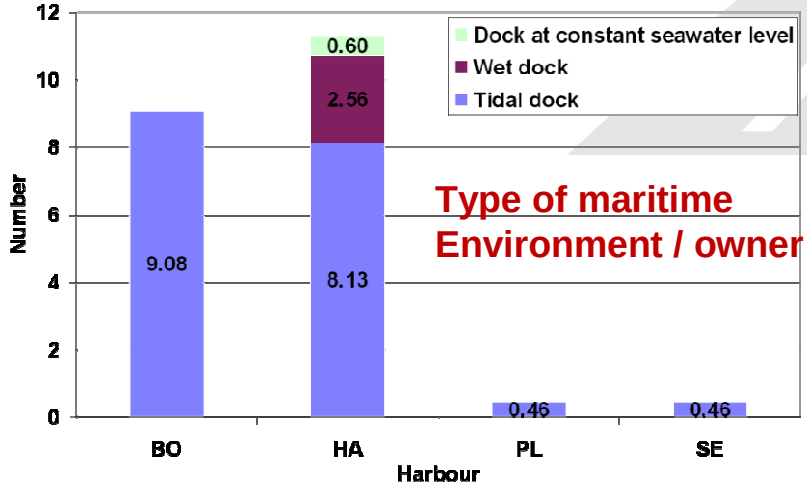


French experience

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

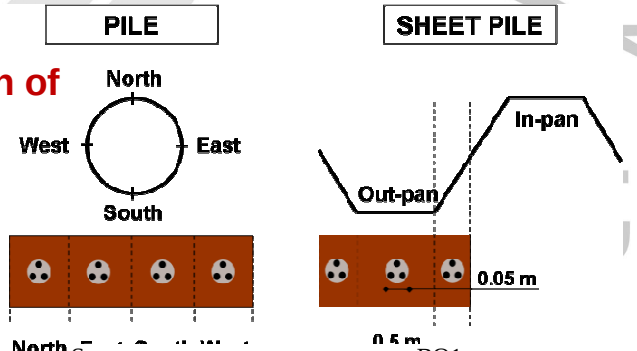
(100 000 measurements)

- 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)	7.2	19.5		13.7	13.3	8.1
	20.7					
pH	7.8	8.1		8.1	8.0	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)

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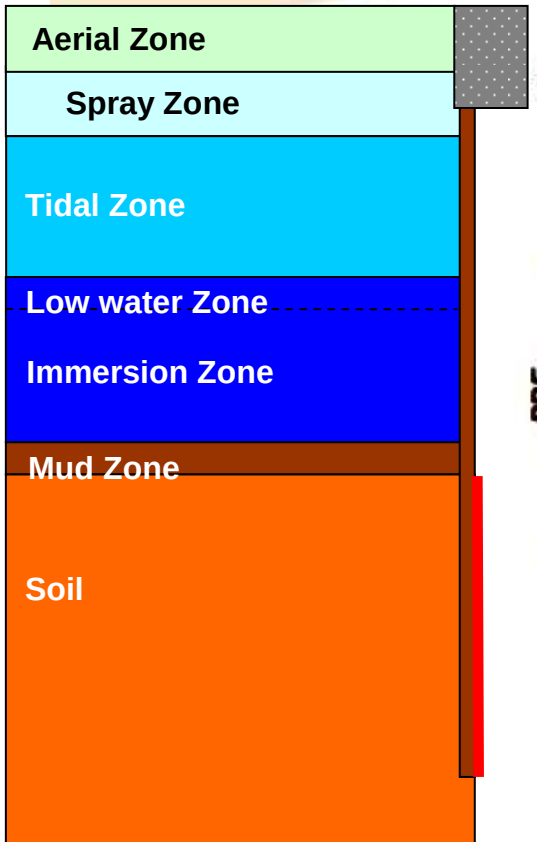
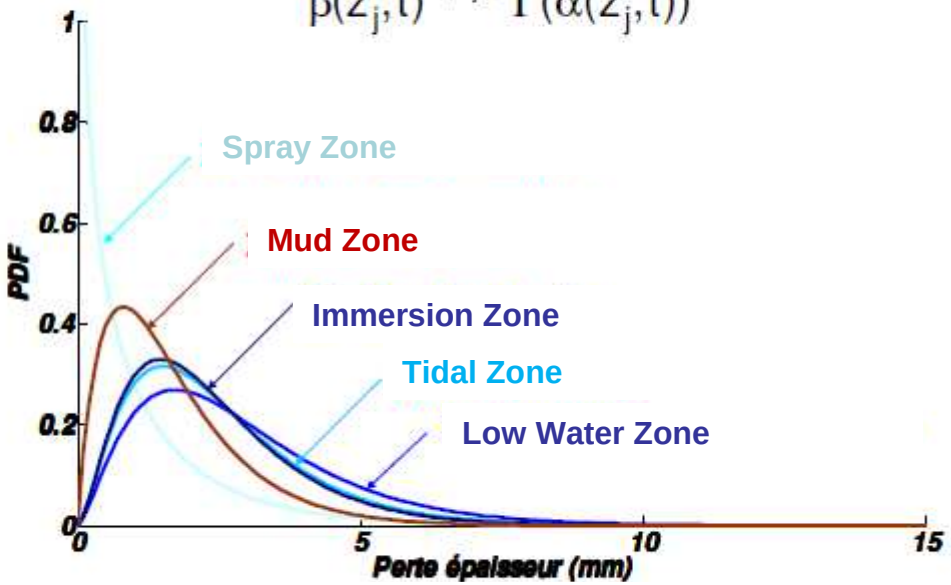


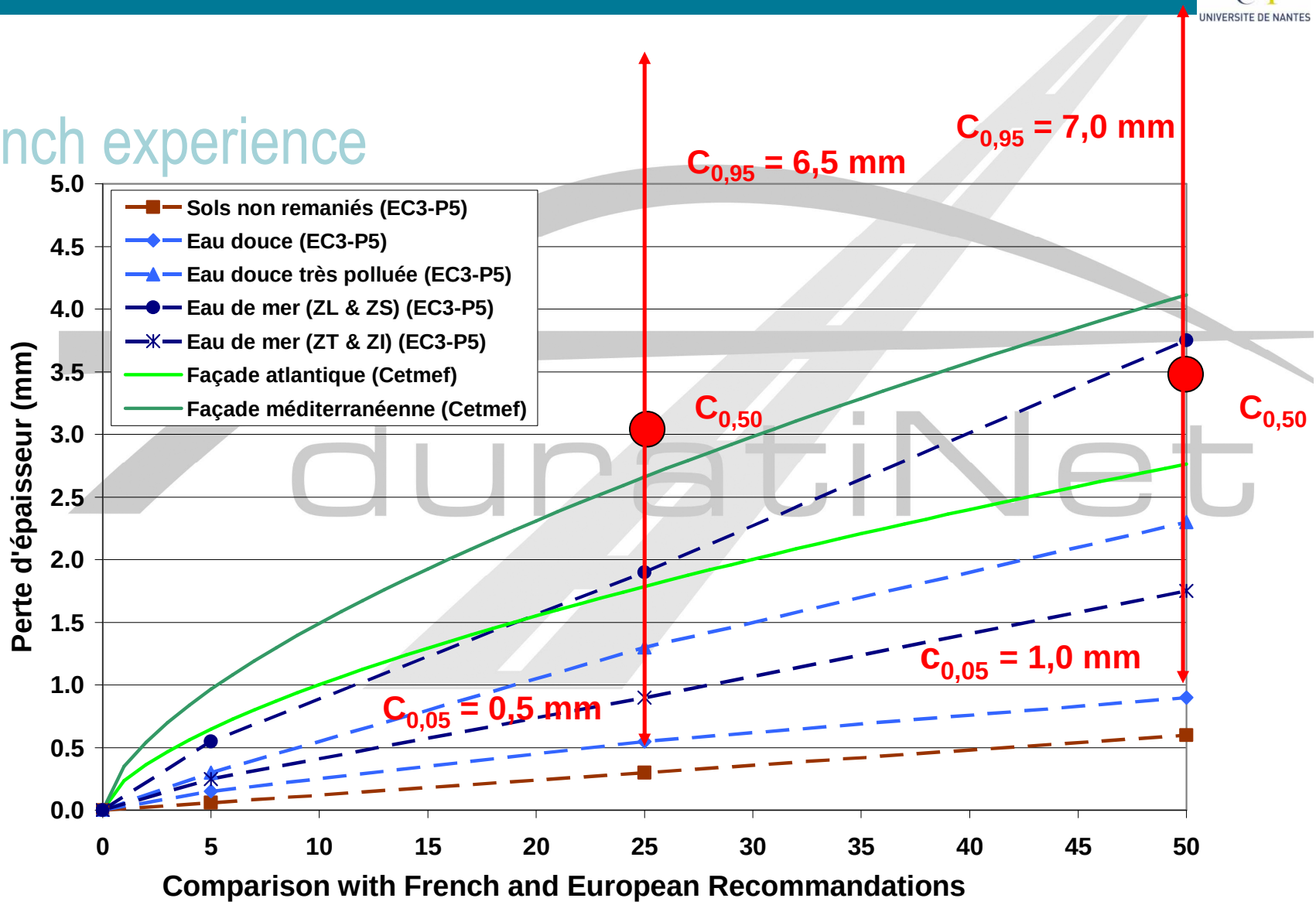
Loi de probabilité Gamma de paramètres α et β :

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



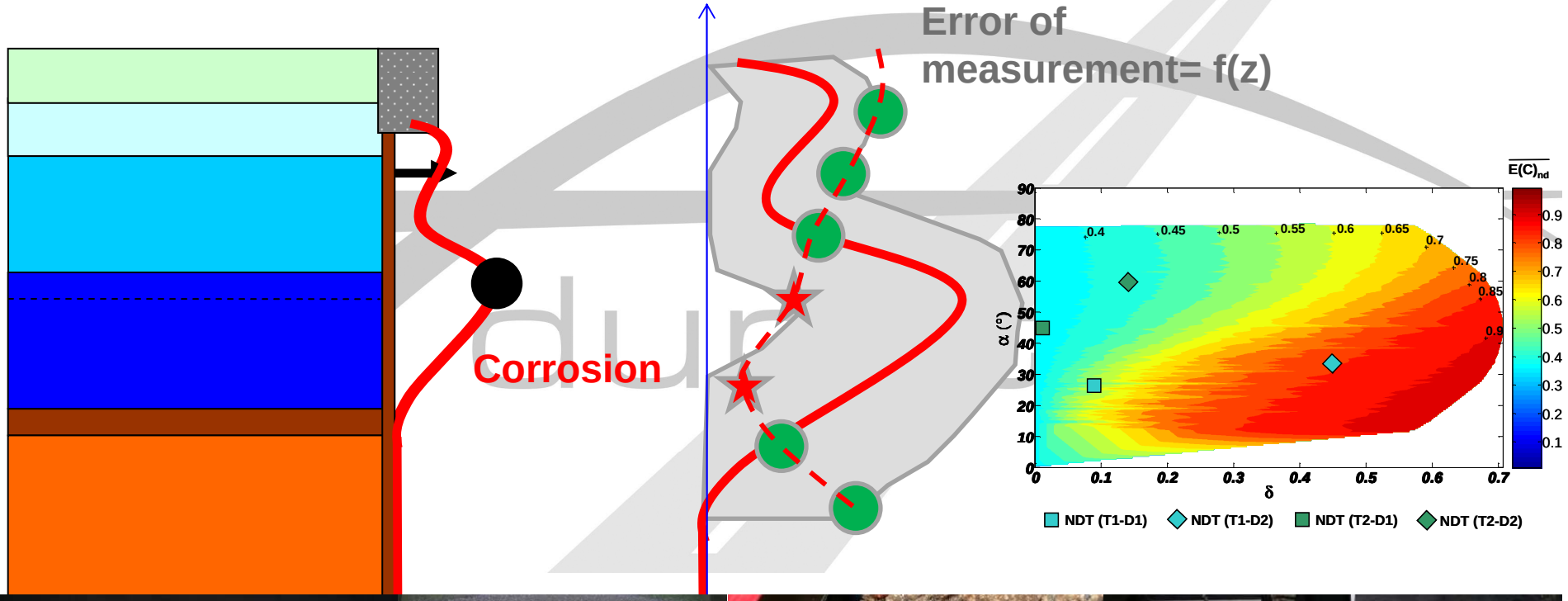
Distribution of the loss of thickness of steel after 25 years

French experience



¨Problematic of inspection …

… in few words



To be made : objectives of Duratinet

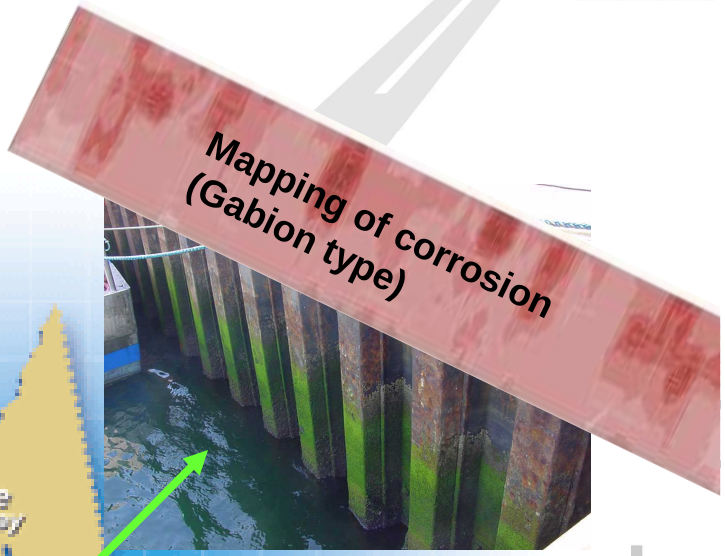
- Share Practices and data in the Atlantic area
- Provide guide-lines based on risk analysis in view to optimize the number of measurements at each inspection time and the number of inspections (in link with WG2)

duratiNet

Complete the knowledge : specimens on site (documented)

Corrosion rate

Data analysis (residual thickness – ROC)



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- 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

MEDACHS

- 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	Paint 1	Paint 2	Paint 3	Paint 4	Paint 5
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

CeTe Nord Picardie — Centre d'Études Techniques de l'Équipement

PORT ATLANTIQUE Nantes Saint-Nazaire

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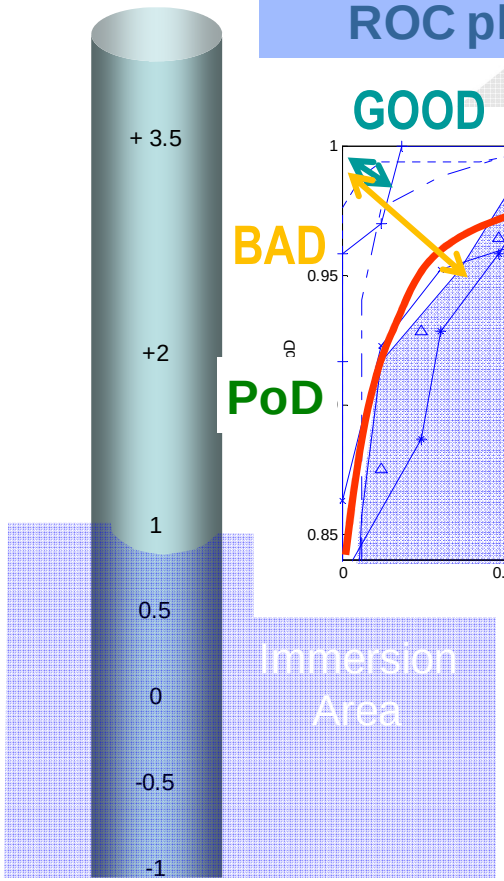
- Provide data base for measurement of NDT tool performance on site. Developp the use of connex data : video-tapes before painting. **NEW**

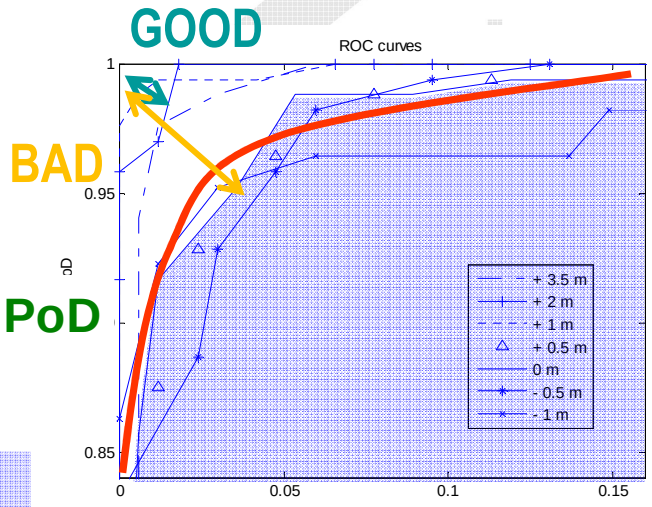
Results of Medachs project

MEDACHS

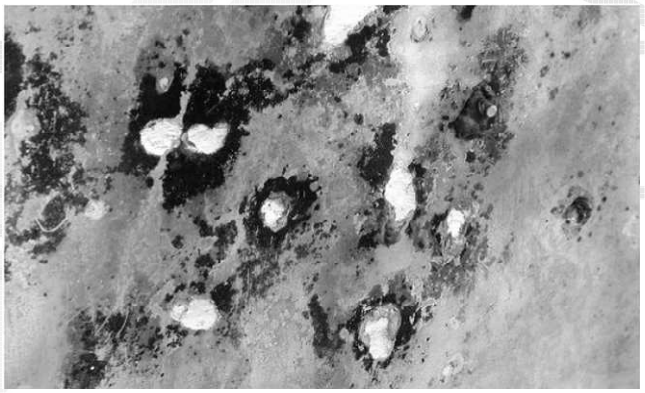
Uniform corrosion (from data in Brest, Nantes, Boulogne)

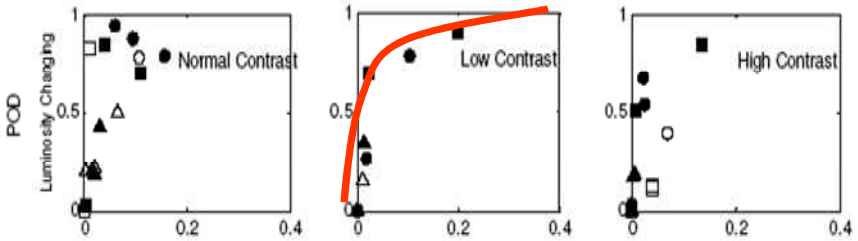
ROC plot (thickness)





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 !

Keep in mind the injuries: 7 bridges / year in Ireland for instance