duratiNet

Journée de Formation du projet Européen **DURATINET**

Durable Transport Infrastructures in the Atlantic Area Network

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ACESSIBILITY & TRANSPORTS

Project nr 2008-1/049

European Union
European Regional Development Fund

Investing in our common future

ATLANTIC AREA
Transnational Programme

Presentation Overview

1. DuratiNet Project Context
2. Project Objectives
3. Acheiving Objectives and Required Activities
4. Discussion under each main Activity
5. Overall DuratiNet Deleverables
6. Questions

+ enquête nationale en France- UoN

FR CNRS 3473

Atlantic area regions

Structural Funds 2007 - 2013: Transnational Cooperation

Atlantic Action Plan

Maritime Strategy for the Atlantic Ocean Area

The European Commission approves on 13th May 2013 the Action Plan for a Maritime Strategy in the Atlantic Area. The Action Plan aims to enhance marine and maritime economy in the **Atlantic Ocean area**. Through a common work of EU Atlantic Member States, Regions and European Commission, it sets out four priorities for research and investment to drive "**blue economy**" forwards, while preserving the environmental and ecological strength:

- **Promote entrepreneurship and innovation;**
- **Protect, secure and enhance the marine coastal environment;**
- **Improve accessibility and connectivity;**
- **Create a socially inclusive and sustainable model of regional development.**

The priorities aims to respond to challenges and opportunities facing the Atlantic region under five themes: **implementing the ecosystem approach; reducing Europe's carbon footprint; sustainable exploitation of the Atlantic seafloor's natural resources; responding to threats and emergencies; social inclusive growth.** The Atlantic Area Programme currently supports **42 projects related to those maritime and marine areas.**

Project Context

Project Context

Atlantic Area Transport Infrastructure

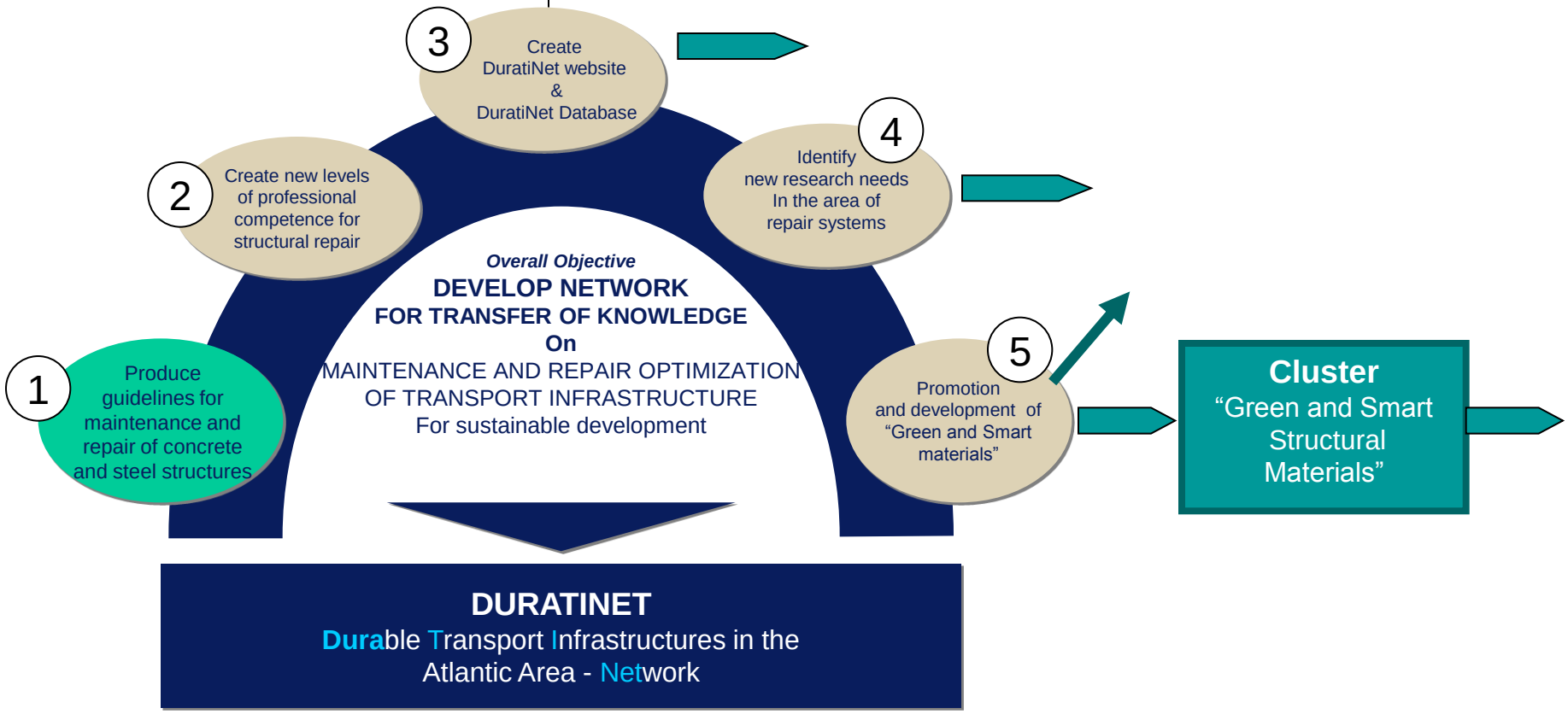
- High proportion of our structures are > 30 years old
- Most structures require repair /rehabilitation
- Some repaired structures exhibit poor repair performance
- Sustainability of construction must be considered (energy and environmental impacts)

Project Objectives

Project Objectives

SHORT - TERM OBJECTIVES AND RESULTS

LONG-TERM OBJECTIVES AND RESULTS



Acheiving Objectives

PARTNERSHIP

17 Partners

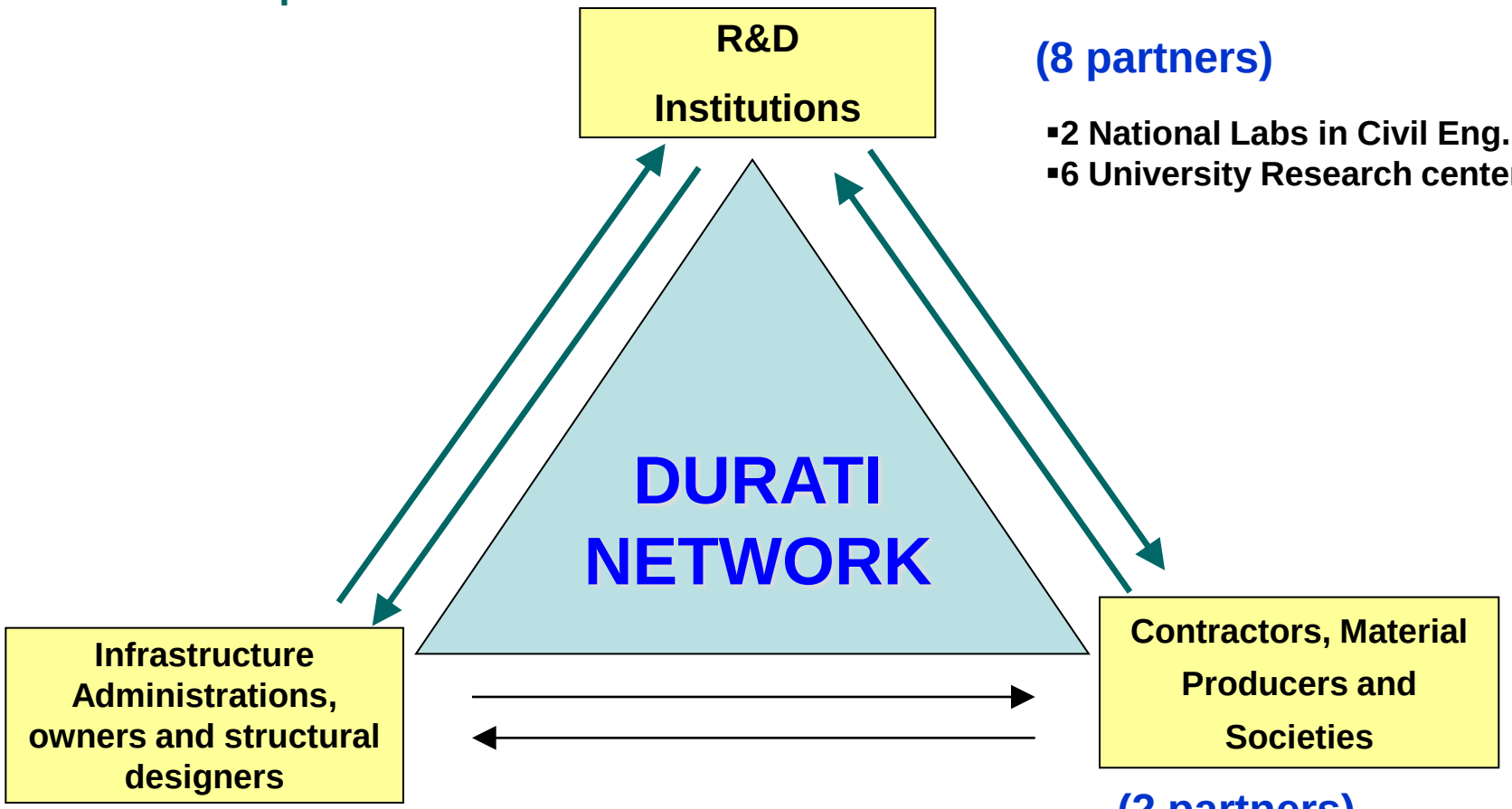
Portugal (6)
Spain (3)
France (5)
Ireland (2)
United Kingdom (1)

60 people during 4 years

List of 6 Main Activities

- Activity 2: Maintenance optimisation and decision tools
- Activity 3: Reinforced and prestressed concrete structures maintenance/repair
- Activity 4: Steel maintenance and repair
- Activity 5: Repair systems – quality control
- Activity 6: “Green” and smart structural materials, repair products and systems
- Activity 7: Performance evaluation of structural and new repair materials

Partnership



(8 partners)

- 2 National Labs in Civil Eng.
- 6 University Research centers

(7 partners)

- Highways
- Ports
- Railways

(2 partners)

- Repair Contractor
- A Non-Profit Society

PROJECT ACTIVITIES

SHORT - TERM OBJECTIVES AND RESULTS

LONG-TERM OBJECTIVES AND RESULTS

Objective 1

Activity 2
Maintenance optimization and decision tools

Activity 3
Reinforced & prestressed concrete structures repair

Activity 4
Steel structures repair

Objective 2

Activity 9
Comunication & dissemination

Objective 3

Activity 8
DURATINET SITE & DB-DURATI

Objective 4

Activity 5
Quality control needs in repair

Activity 7
Performance evaluation of structural and new repair materials

Objective 5

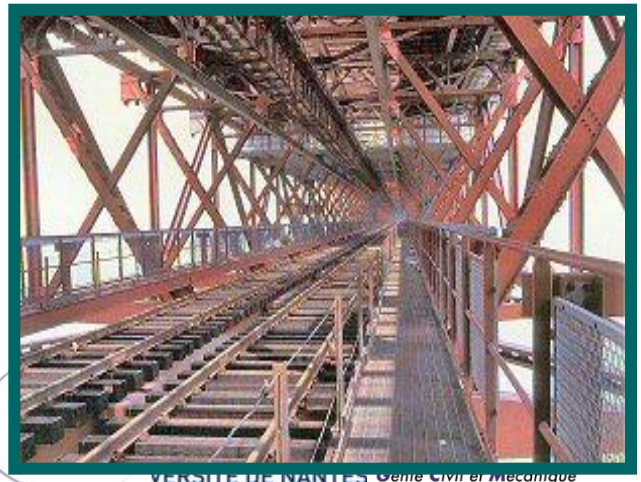
Activity 6
Smart & green structural and repair materials

Activity 10
DURATINET PROJECT MANAGEMENT

Activity 1
Project preparation

Activity 2

Maintenance Optimization and Decision Tools



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Activity 2: Problem Definition

For a given structure how do we decide upon the optimal maintenance strategy as a function of age, condition, importance, **required remaining life** etc. in a robust/repeatable manner, avoiding generalisation/excessive conservatism such that our maintenance budget is optimised???

e.g. *Storstroem 1937, 3.2km*

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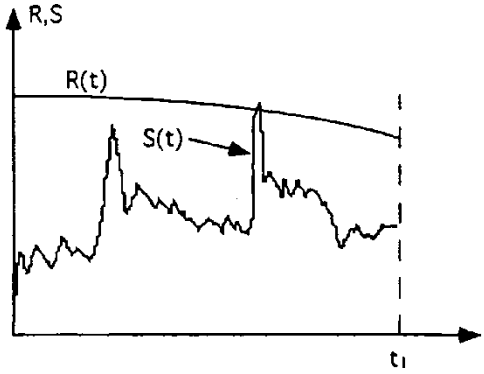
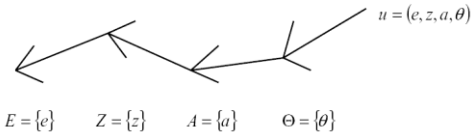
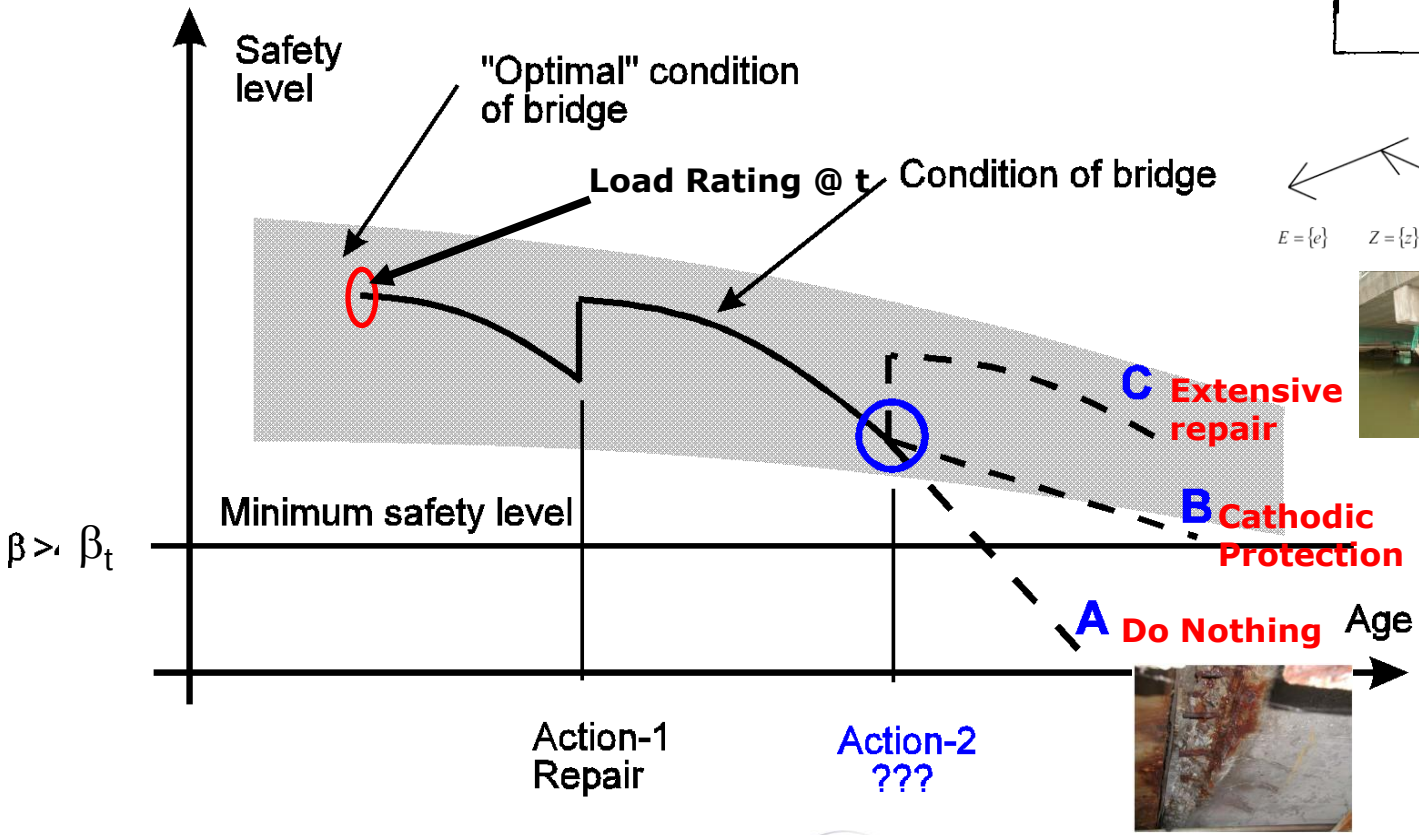
Activity 2: Problem Definition



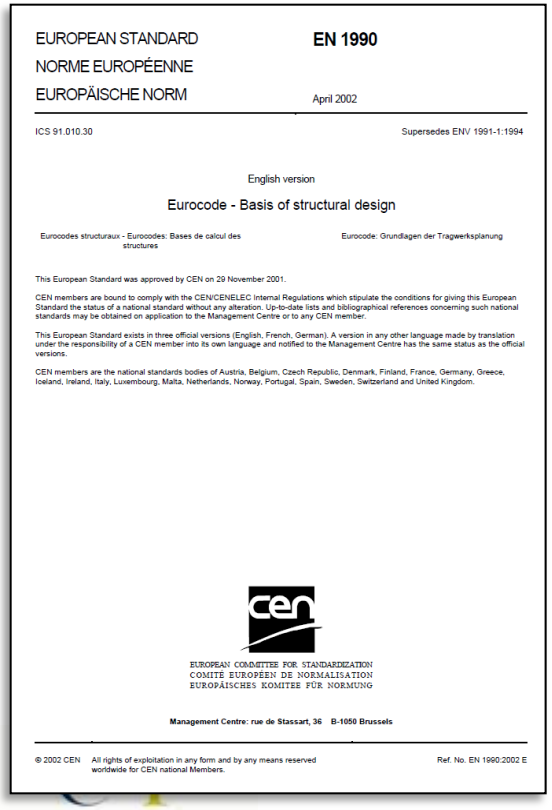




Activity 2: Probability Based Maintenance Optimisation

Legal Basis – Eurocode 1 Basis of Design

Safety Level NEVER Compromised – Rather Optimised



EUROPEAN STANDARD **EN 1990**
NORME EUROPÉENNE
EUROPÄISCHE NORM
April 2002

ICS 91.010.30 Supersedes ENV 1991-1:1994

English version

Eurocode - Basis of structural design

Eurocodes structuraux - Eurocodes: Bases de calcul des structures | Eurocode: Grundlagen der Tragwerksplanung

This European Standard was approved by CEN on 29 November 2001.

CEN members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration. Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the Management Centre or to any CEN member.

This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CEN member into its own language and notified to the Management Centre has the same status as the official versions.

CEN members are the national standards bodies of Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Malta, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and United Kingdom.

cen

EUROPEAN COMMITTEE FOR STANDARDIZATION
COMITÉ EUROPÉEN DE NORMALISATION
EUROPÄISCHES KOMITEE FÜR NORMUNG

Management Centre: rue de Stassart, 36 B-1050 Brussels

Ref. No. EN 1990:2002 E

3.5 Limit state design

(1)P Design for limit states shall be based on the use of structural and load models for relevant limit states.

(2)P It shall be verified that no limit state is exceeded when relevant design values for
– actions,
– material properties, or
– product properties, and
– geometrical data
are used in these models.

(3)P The verifications shall be carried out for all relevant design situations and load cases.

(4) The requirements of 3.5(1)P should be achieved by the partial factor method, described in section 6.

(5) As an alternative, a design directly based on probabilistic methods may be used.

NOTE 1 The relevant authority can give specific conditions for use.

NOTE 2 For a basis of probabilistic methods, see Annex C.

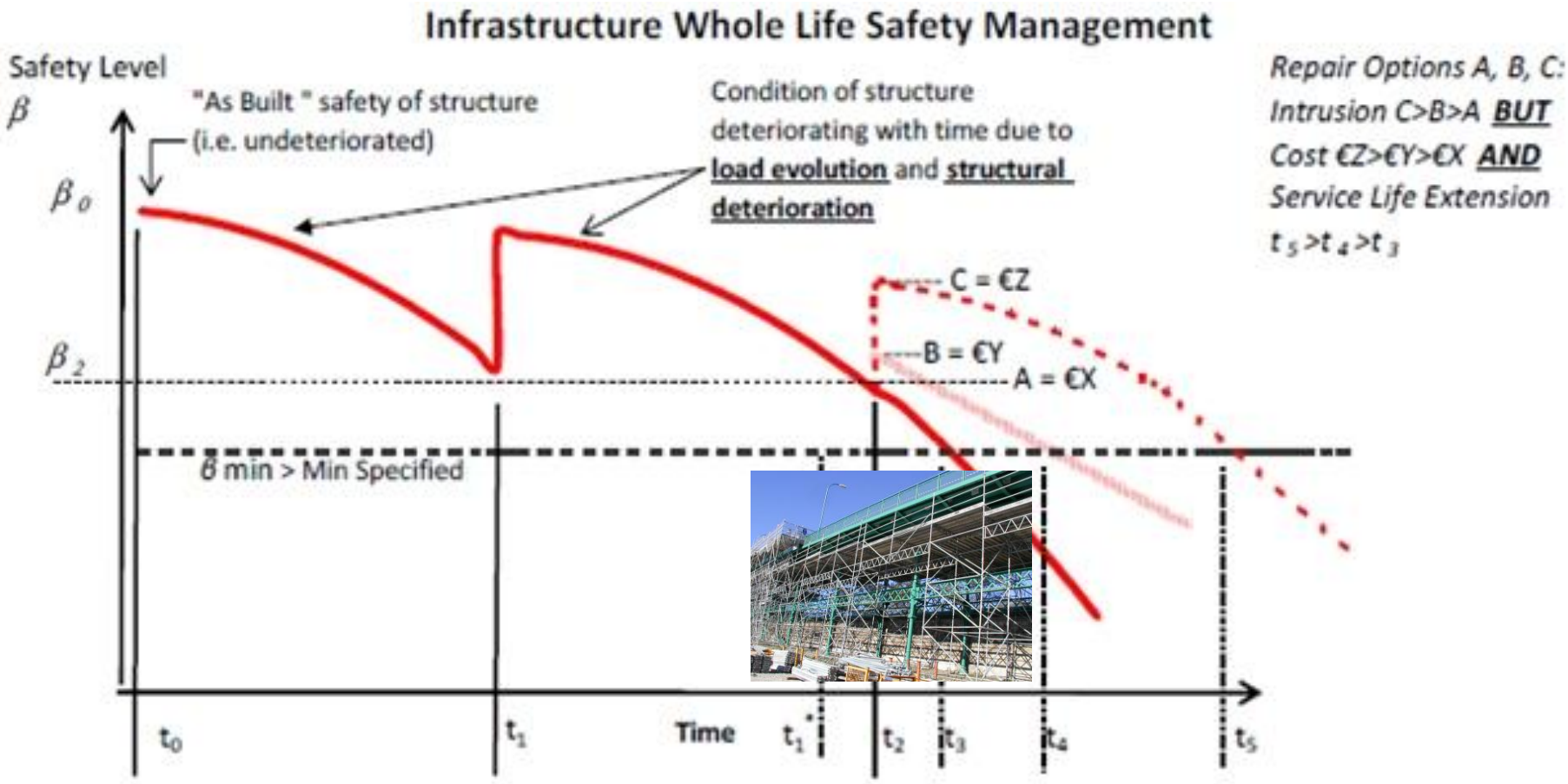
(6)P The selected design situations shall be considered and critical load cases identified.

(7) For a particular verification load cases should be selected, identifying compatible load arrangements, sets of deformations and imperfections that should be considered simultaneously with fixed variable actions and permanent actions.

(8)P Possible deviations from the assumed directions or positions of actions shall be taken into account.

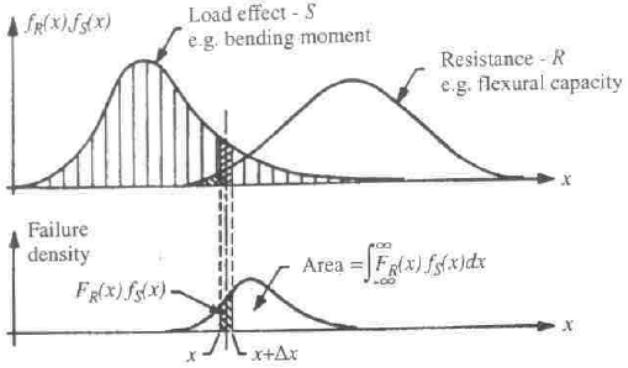
(9) Structural and load models can be either physical models or mathematical models.

Activity 2: Problem Definition



Activity 2: Probability Based Maintenance Optimisation

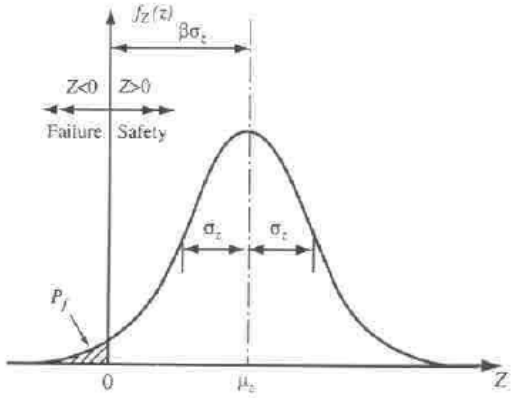
Statistical Modelling of:
Loads
Resistances
Uncertainties
Updating based upon results of tests/inspections



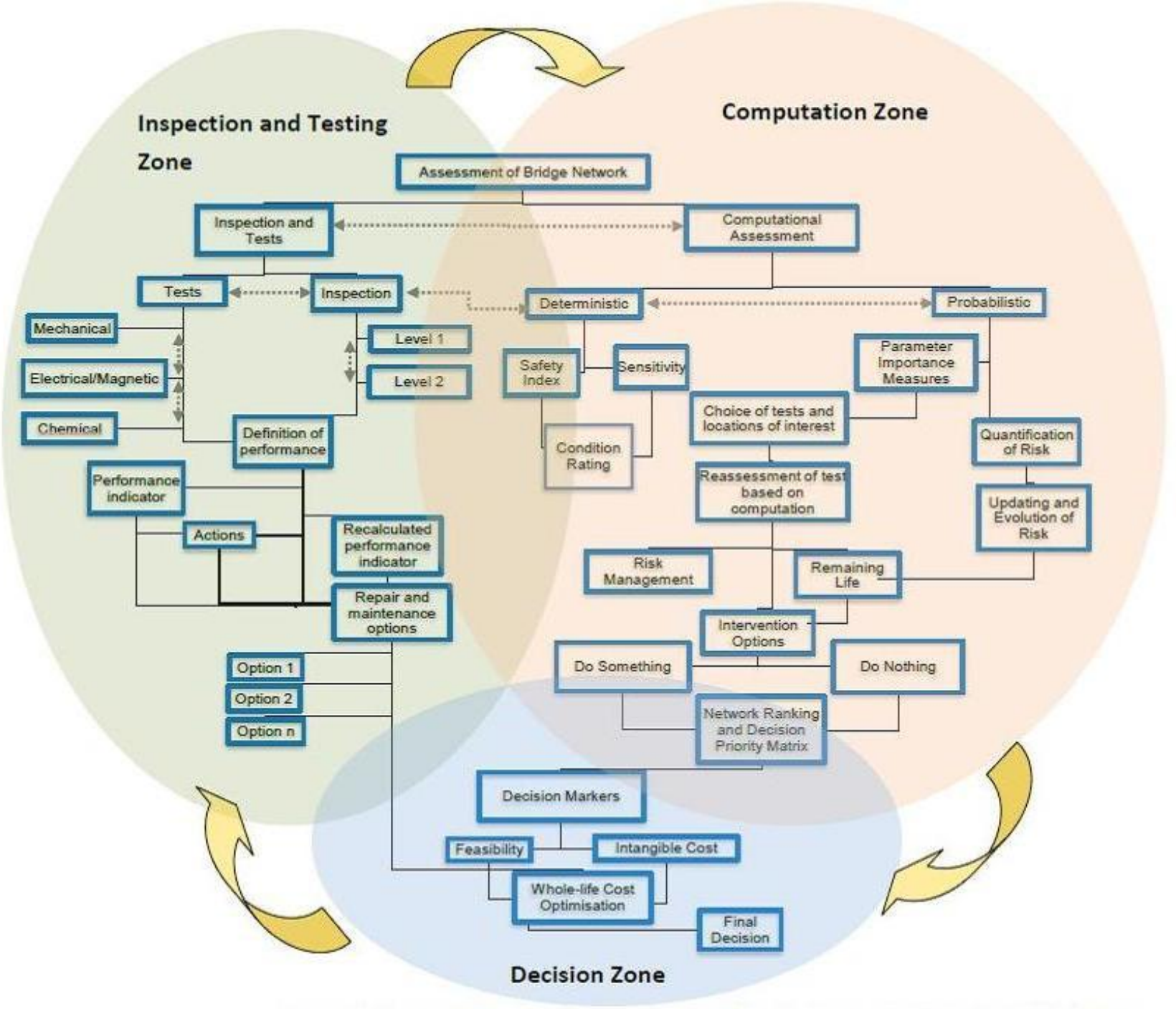
Purpose:
Cut strengthening or rehabilitation costs **without** compromising the safety level

Table 1 – Minimum Safety Levels Specified by the Eurocode (EN1990:2002)

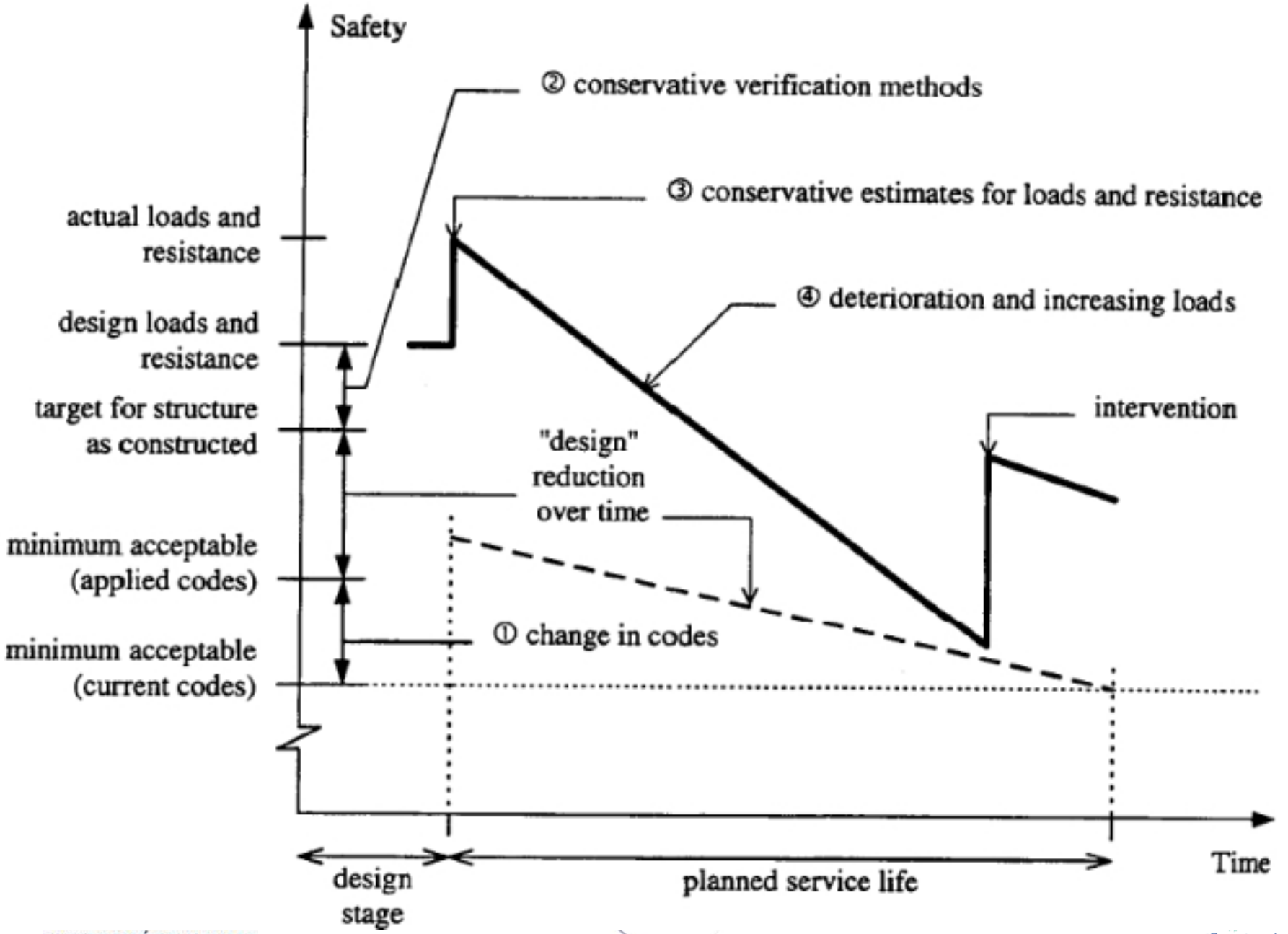
Reliability Class	Minimum values for β	
	1 year reference period	50 year reference period
CC3 (RC3)	5.2	4.3
CC2 (RC2)	4.7	3.8
CC1 (RC1)	4.2	3.3



Essentially a Bridge specific "code" is obtained



Interactive Infrastructure Maintenance Management: Hierarchical "Mandala"


Safety
② conservative verification methods
③ conservative estimates for loads and resistance
④ deterioration and increasing loads
actual loads and resistance
design loads and resistance
target for structure as constructed
"design" reduction over time
intervention
minimum acceptable (applied codes)
① change in codes
minimum acceptable (current codes)
Time
design stage
planned service life

Activity 3

Maintenance and Repair of Reinforced and Pre-stressed Concrete

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Activity 3: Primary Areas Investigated

3.1 Review of requirements for concrete durability

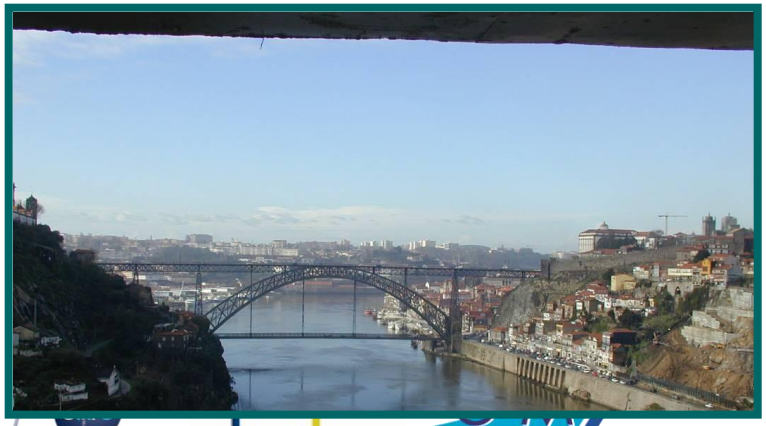
3.2 Mechanisms of damage

3.3 Assessment and inspection techniques

3.4 Available repair techniques

Activity 4

Steel Maintenance and Repair



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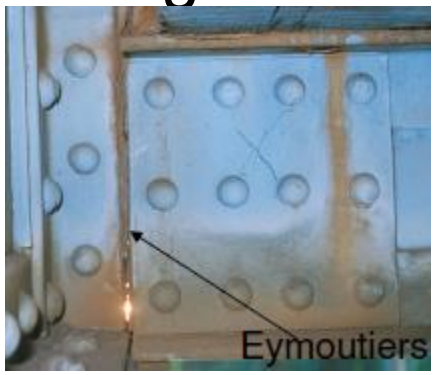
Activity 4: Problem - Aging Mechanisims and Steel Structure Stock

- Fatigue Damage



- 20% of French bridges are steel
- 2% of Irish bridges are steel
- 1/3 of the steel structures in the Atlantic Area are more than 100 years old

CORROSION feuilletante

CORROSION CREUSANTE

4.3 Habour structures – Chalanges and Solutions

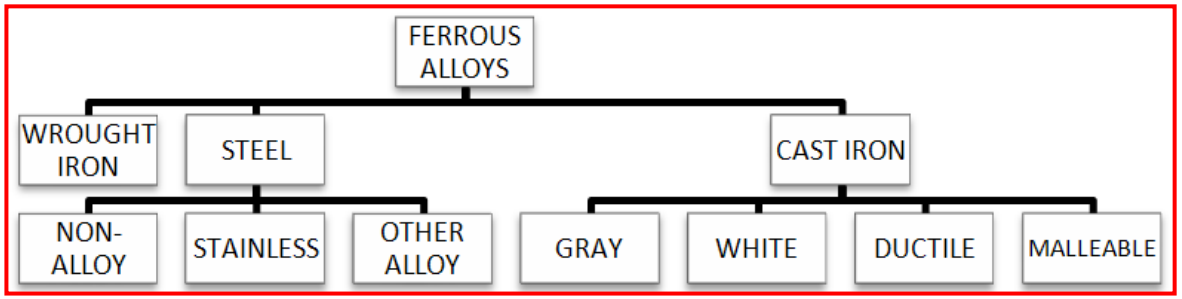
- The corrosion process in Harbour structures is difficult to model due to **numerous time-variant and space-dependent factors** such as; temperature, dissolved oxygen, salinity, tide level, suspended materials (bio-corrosion), pollution, water flow/waves, abrasive materials etc.
- Few on-site measurements are available and these are not always well documented
- On-site measurements are costly and difficult to obtain
- Therefore, need to gather data in a well documented database

To Acheive Activity 4 Objectives

- Share Practices and data in the Atlantic area
- Provide guidelines based on risk analysis with a view to optimize the number of measurement at each inspection and the frequency of inspections
- Provide guidelines based on risk analysis for maintenance (painting) which outlines proceedures for maintenance feedback i.e.document environmental conditions during painting works / type of product etc.
- Provide **data base for measurement of NDT tool performance on site**
- **Developp the use of connex data** : video-tapes before painting

Durability factors

- **Environment – atmospheric|water|soil**
  - **Classification**
  - **Environmental variables**
  - **Environmental corrosivity classification**
- **Material - Ferrous alloys**
  - **Classification**
  - **Properties**
    - **Chemical**
    - **Mechanical**
    - **Physical**
    - **Metallurgical**



Deterioration

- **Defects**
  - **Classification (type, component, subtype)**


Contamination


Deformation


Deterioration


Discontinuity


Displacement


Loss of material

- **Deterioration mechanisms**
  - **Chemical & Biological**
    - **Corrosion**
  - **Physical**
    - **Fatigue**
  - **Other**


Deterioration due to corrosion


Discontinuity due to fatigue (cyclic loading)

Testing techniques

- **NDT methods**
  - Visual examination
  - Eddy/Focault current
  - Magnetic particles
  - Liquid penetrant
  - Radio/Gammagraphy
  - Acoustic emission
  - Ultrasonic
  - Dynamic vibration
  - Magnetic flux and flux leakage

- **DT methods**
  - Tensile
  - Charpy impact
  - Plane-strain fracture toughness
  - Axial-force controlled method (fatigue)
  - Fatigue crack growth method
  - Electrochemical
  - Hardness
  - Fractography
  - Metallography
  - Chemical analysis





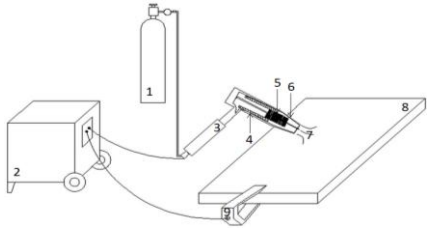
Repair methods

- **Methods for repairing damage in steel elements**
  - **Stop hole**
  - **Welding**
  - **Bolting**
  - **Riveting**
  - **Adding steel elements**
  - **Replacement**
  - **Mechanical straightening**
  - **Heat straightening**
  - **Repair with FRP**



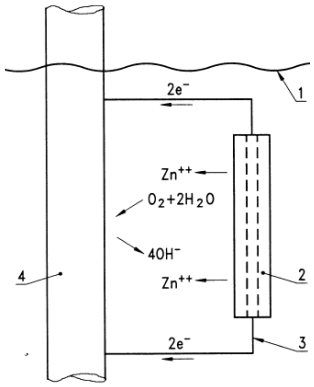


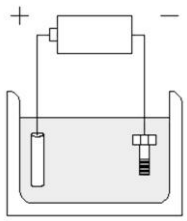

- **Methods for improving fatigue performance**
  - **Grinding**
  - **Peening**
  - **TIG dressing**

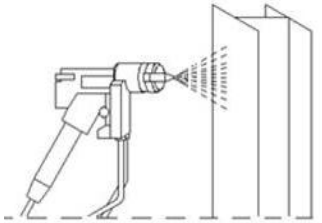



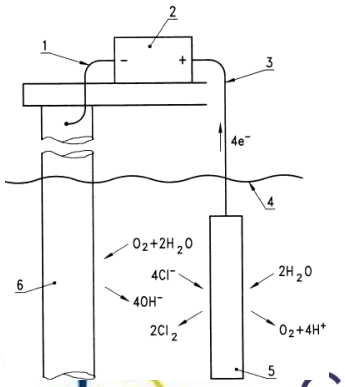
Protection systems

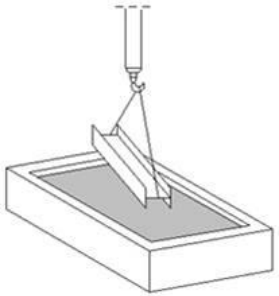
- Cathodic protection
- Paint systems
- Metallic coatings

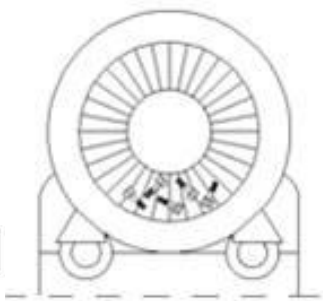






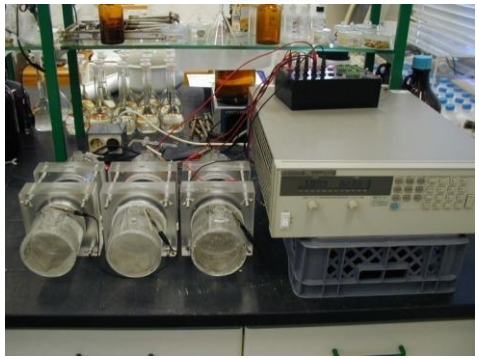


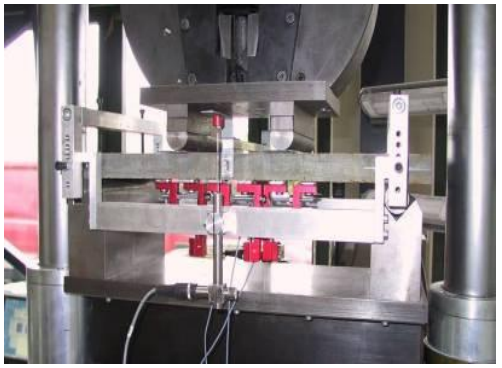




Protection systems

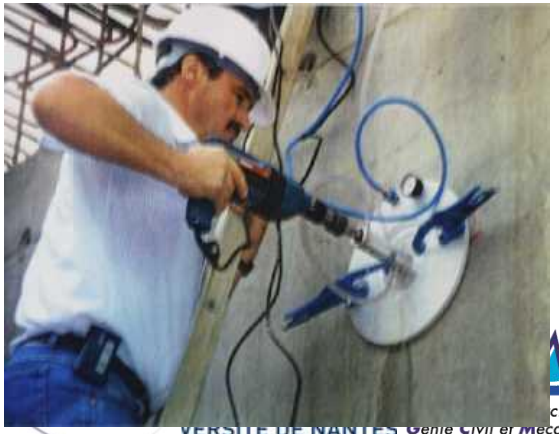
- **Surface preparation**
  - Water, solvent and chemical cleaning
  - Mechanical cleaning including blast-cleaning
  - Flame cleaning





Activity 5

Quality Control Needs for Repair Systems



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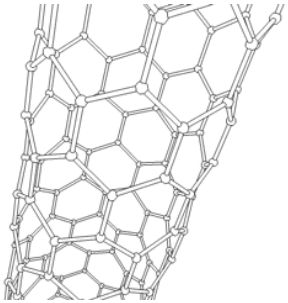
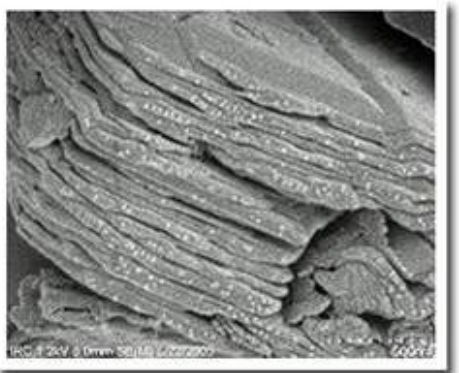
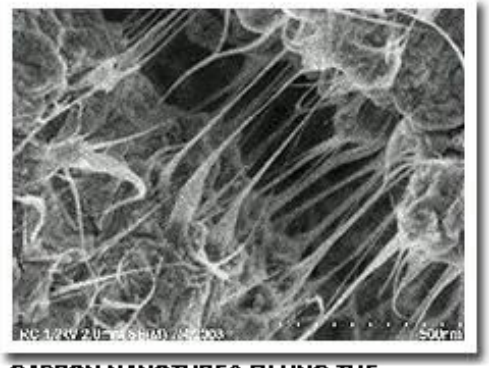


Activity 6

“Green” and Smart Structural Materials, Repair Products and Systems



NANOLAYERS OF CALCIUM ALUMINATE



CARBON NANOTUBES FILLING THE CRACKS IN A CEMENTING COMPOSITE

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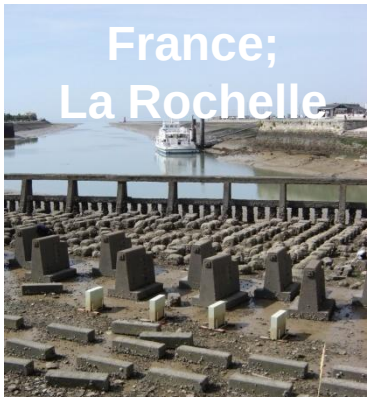

Activity 7

Performance evaluation of structural and new repair materials

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DuratiNet Deliverables

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DuratiNet Website

IN ENGLISH, PORTUGUESE, FRENCH, SPANISH

ICDS12

DuratiNet Website

http://durati.lnec.pt/techguide/index.html

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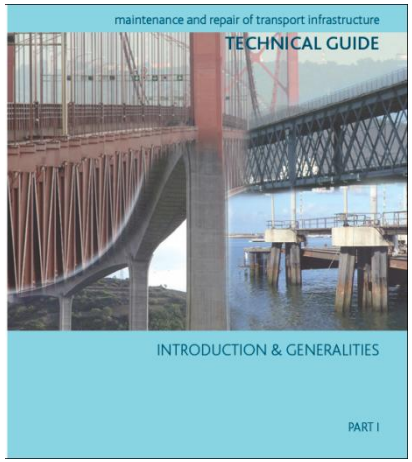
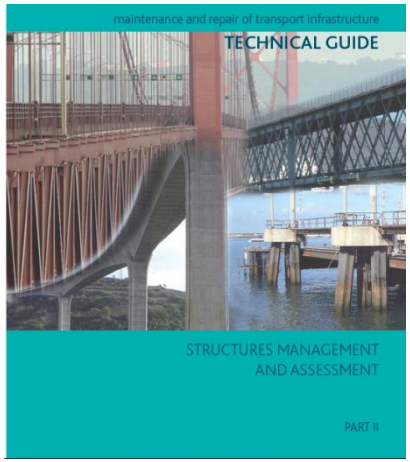
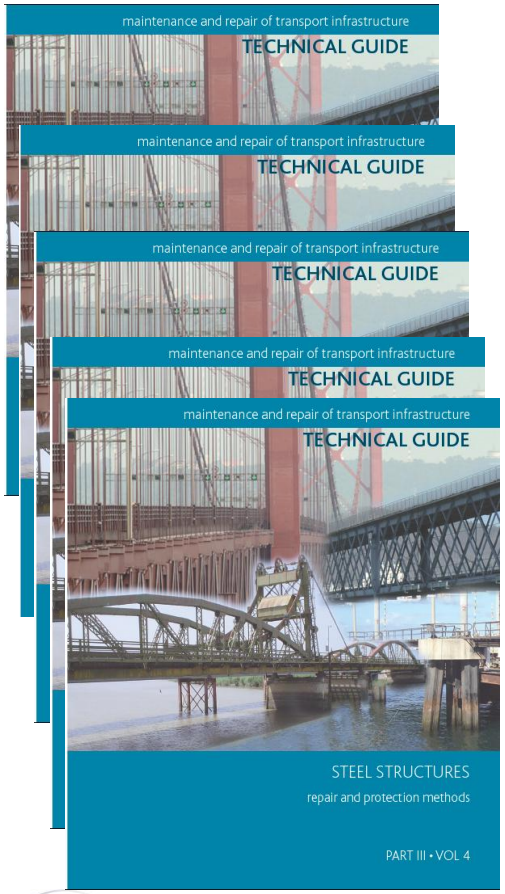
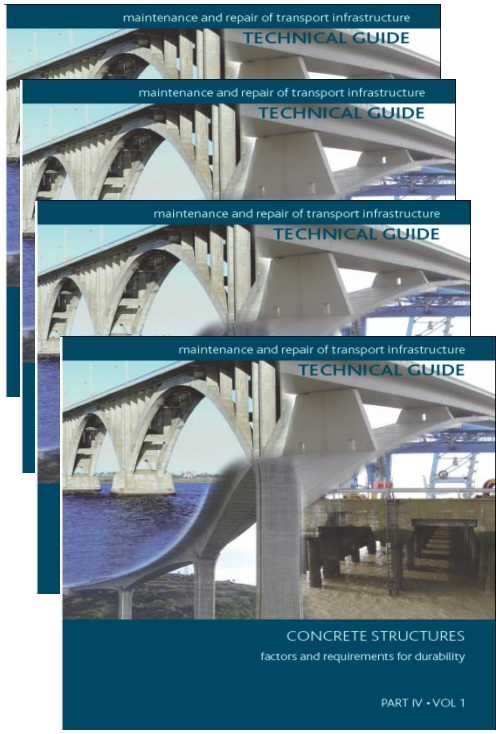
Centrale Nantes

DuratiNet Technical Guides









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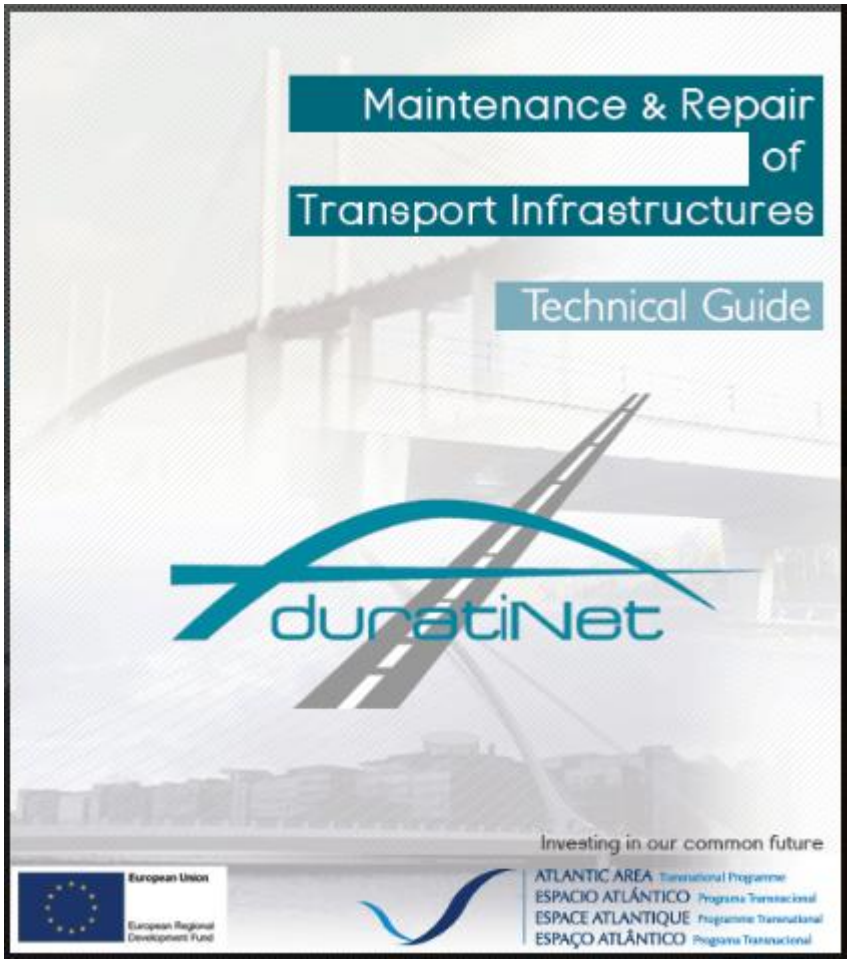
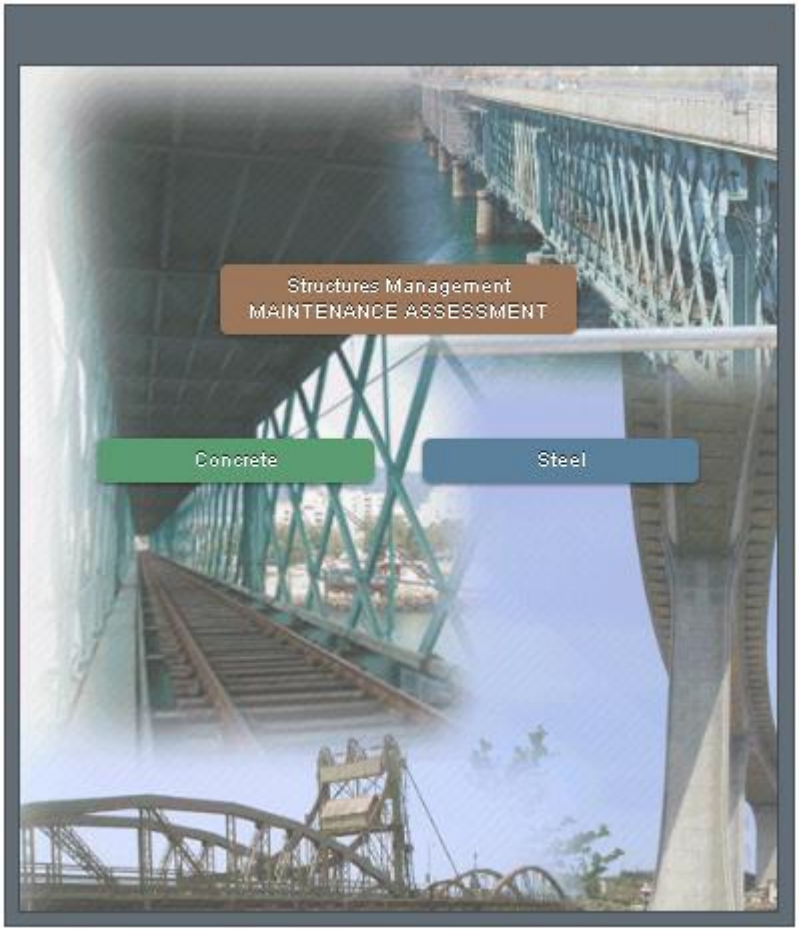
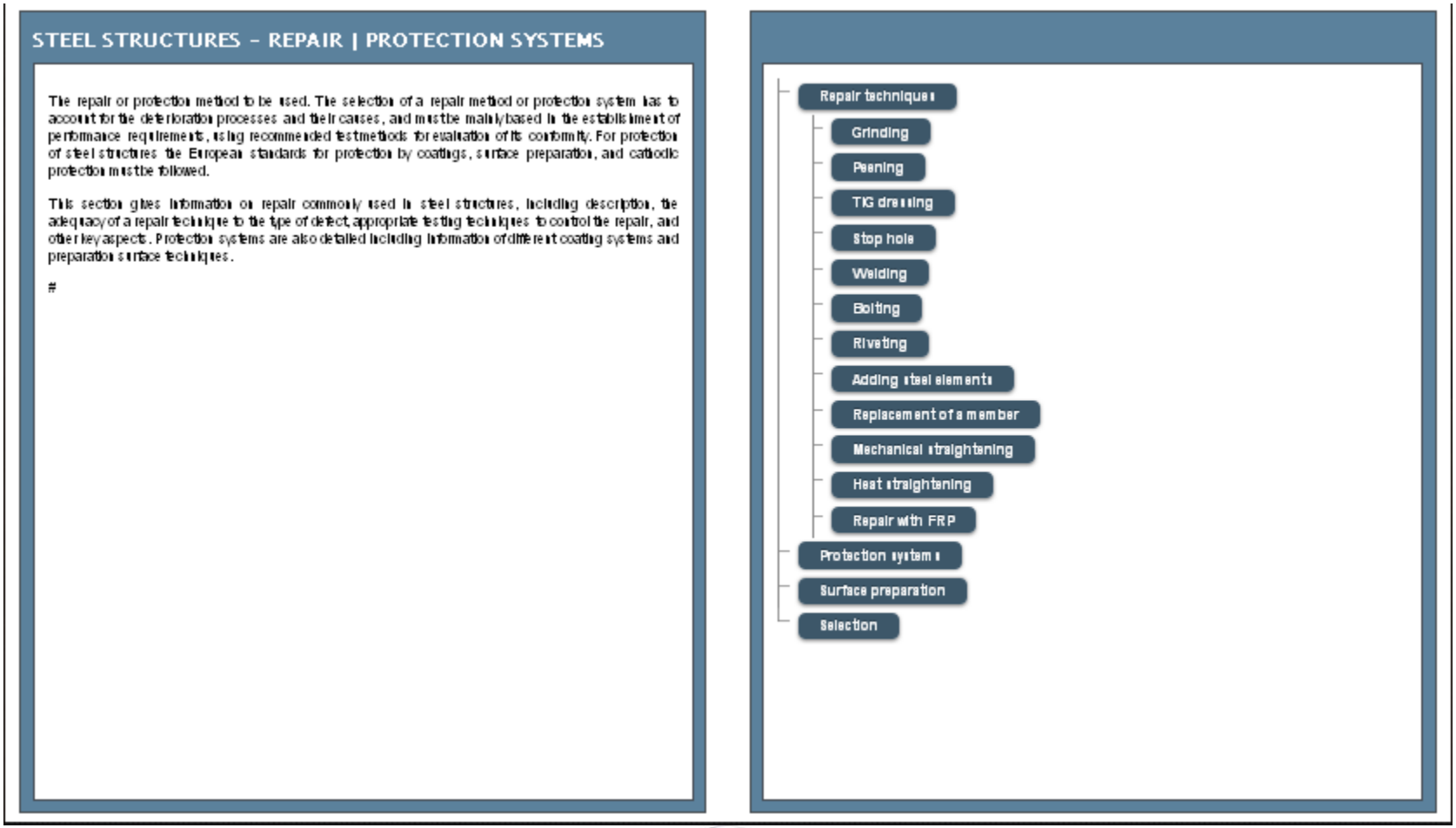
DuratiNet Technical Guide – Web





DuratiNet Technical Guide – Web



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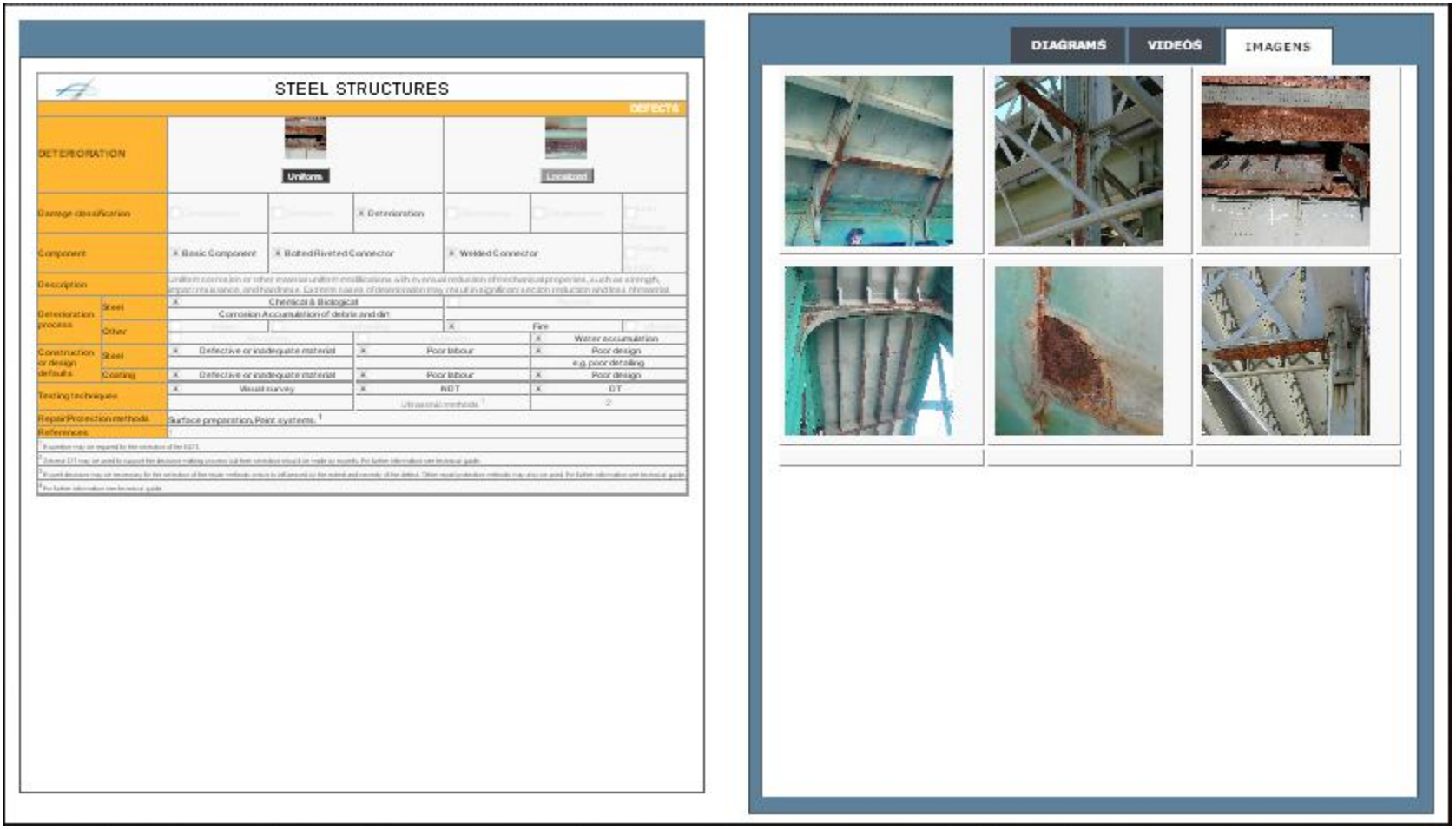

DuratiNet Technical Guide – Web

Démo : dégradation / chimique & biologique / carbonatation

http://www.duratinet.org

http://durati.lnec.pt/techguide/index.html

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