



duratiNet

Durable Transport Infrastructures in the Atlantic Area Network

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Project Leader

Project CONTEXT



EU strategic and priority action guidelines

- ▶ European Cohesion policy and Lisbon agenda
- ▶ European transport policy (EU Decision 884/2004/CE, 29 April 2004)

Trans-European Transport Networks(TEN-T) Interoperability of european transport Networks

- ▶ Gothenburg (Kyoto protocol) agenda
- ▶ Environmental policy (6th EAP-EU 2002-2012)
- ▶ Strategic position of Atlantic Area to east-west connections
- ▶ Relevance of AA on maritime highways
- ▶ Intermodal transportation
- ▶ Reduction of environmental impact and to improve the energetic efficiency
- ▶ Infrastructures repair /rehabilitation needs

Project CONTEXT

Atlantic Area Transport Infrastructures

- High number of structures with > 30 years
- Most structures needs repair /rehabilitation
- Some structures repaired shown low repair performance
- Sustainability of construction (energy and environment impacts)



DURATINET PROJECT

The main goal of the project is to create the network of excellence DURATINET

➤ to facilitate an efficient exchange and transfer of knowledge on maintenance of concrete and steel structures namely as it concerns the assessment and repairing of structures

> to promote the durability, safety and sustainability of transport infrastructures in the **Atlantic Area**,

turning these regions more attractive to live in, to work and for competitive business



PRIORITY 3. Improve the accessibility and internal links

OBJECTIVE 1. promote the interoperability between different transportation

 **ACCESSIBILITY & TRANSPORTS**

Project data:

5 Countries PT,SP,FR,IR,UK
17 Partners

2009-2011

TOTAL PROJECT COST- 2. 570 M€
TOTAL ELLIGIBLE COST-2. 480 M€
ERDF FUND (65%) -1. 612 M€

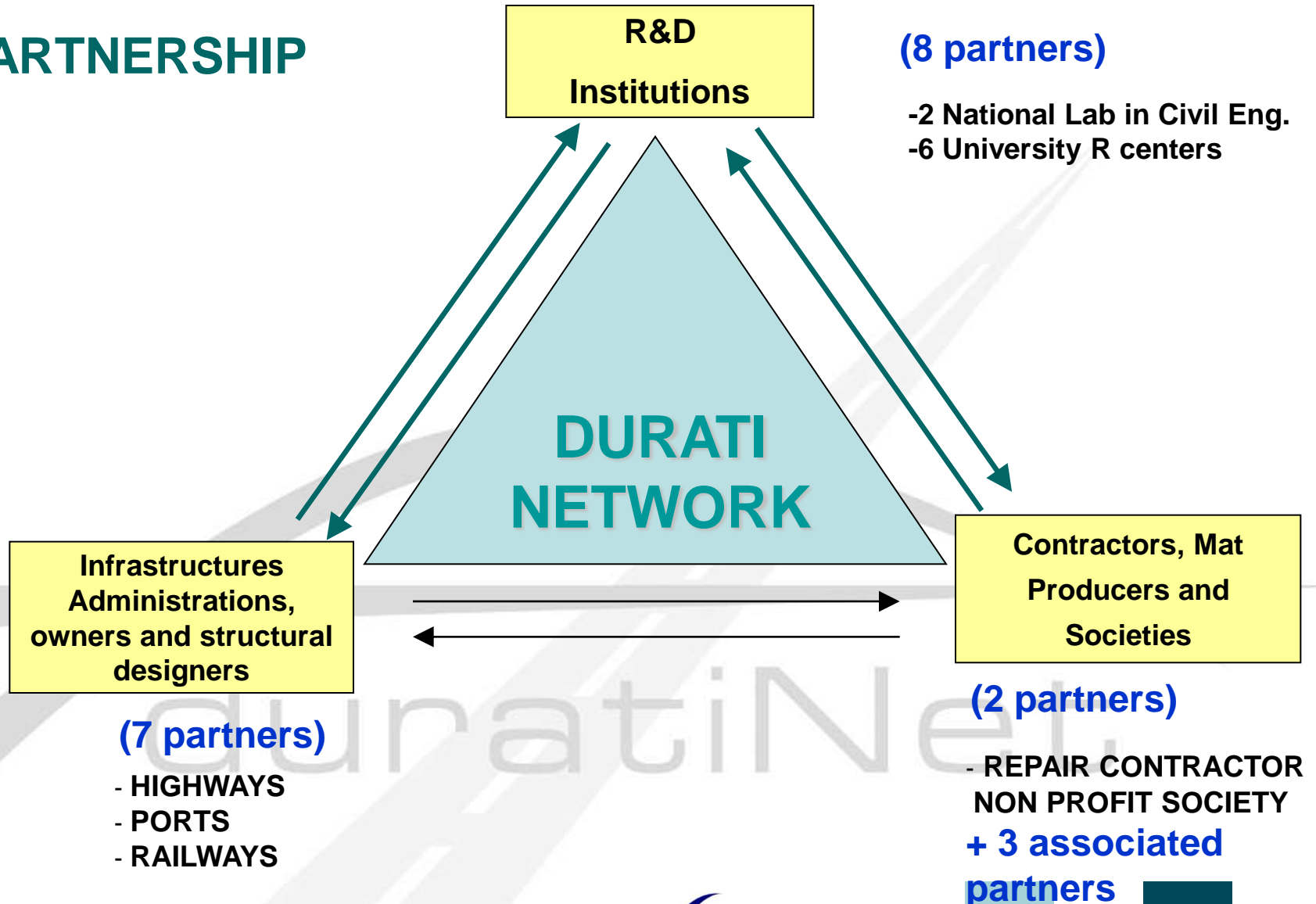


PARTNERSHIP

17 Partners

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

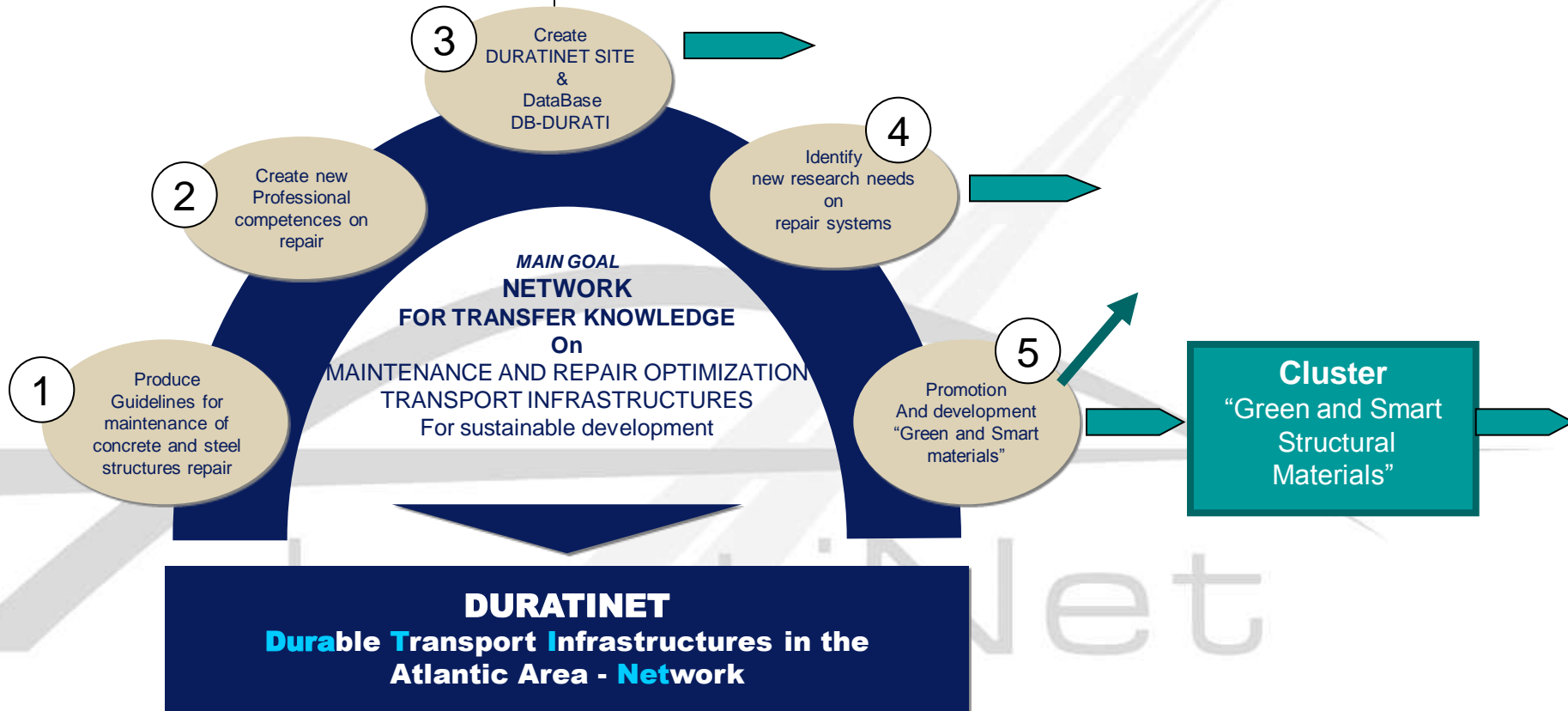
PARTNERSHIP



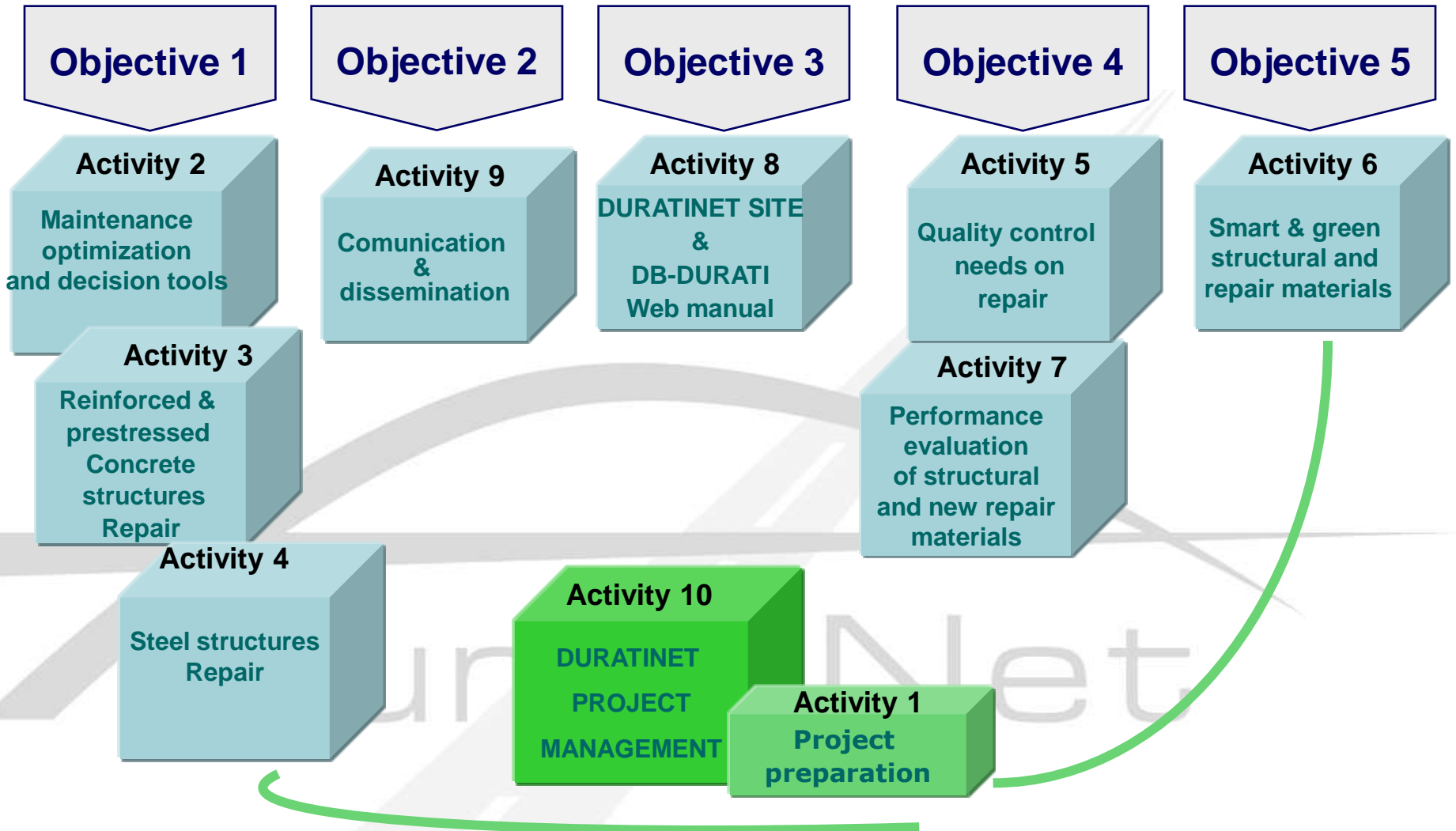
Project Objectives

SHORT - TERM OBJECTIVES AND RESULTS

LONG-TERM OBJECTIVES AND RESULTS



PROJECT ACTIVITIES



ACTIVITY 2



Maintenance optimization and decision tools

- Requirements for maintenance and repairs optimization
- Methodologies to support repair decisions

End-product



- ✓ Web version
- ✓ Printed version



Activity 3

Reinforced and prestressed concrete structures maintenance/repair

- Durability requirements
- Types and degradation mechanisms
- Inspection and diagnosis
- Prevention and service life modelling
- Repair techniques and
- Performance/cost/environmental impact



End-product



- ✓ Web version
- ✓ Printed version



ACTIVITY 4

Steel structures maintenance

- Durability requirements
- Damage mechanisms of steel
- Inspection and evaluation, NDT
- Protection/ repairing



End-product



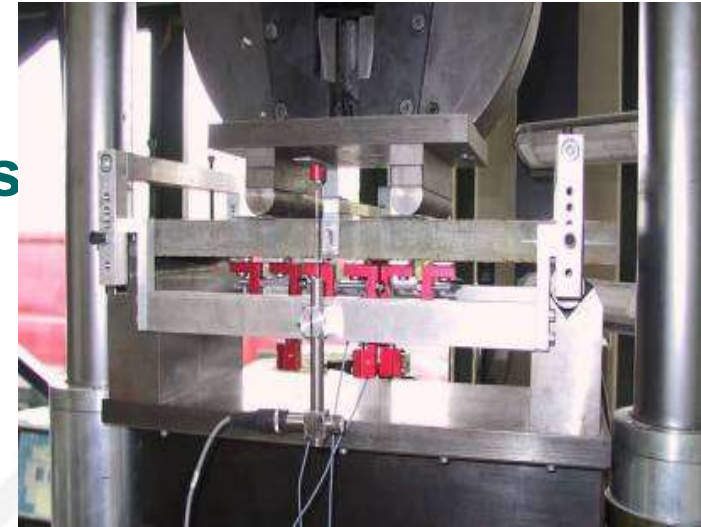
- ✓ Web version
- ✓ Printed version

Steel structures
Guidelines
on repair

ACTIVITY 5

Quality control needs on repair systems

- Implications of harmonized standards on quality control at level of the contractors
- Implications of harmonized standards on quality control at level of materials producers



End-product:

Technical report

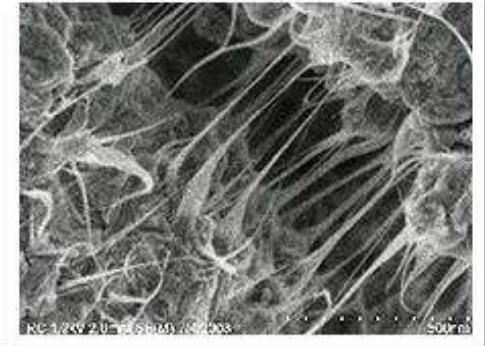
ACTIVITY 6

Smart & green structural and repair materials

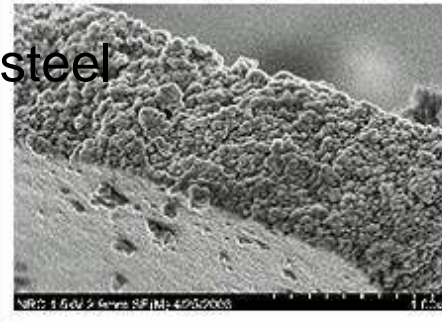
- Concrete with mineral by-products and recycled aggregates
- Water solvents based coatings for steel protection
- Cement with nano particles and nanofibers (Carbon nanotubes)
- Nanomaterials coatings with specific performance properties, easy to clean/Self cleaning and nanoproducts for protection of porous materials
- FRP in new structures and in repairing

End-product:

State -of –the- art Reports



CARBON NANOTUBES FILLING THE CRACKS IN A CEMENTING COMPOSITE



CEMENTING NANOPARTICLES OBTAINED BY THE TECHNIQUES OF "SOFT CHEMISTRY"



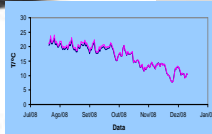
NANOLAYERS OF CALCIUM ALUMINATE



ACTIVITY 6

➤ On-line Monitoring wireless systems

SMART STRUCTURES



Wireless sensor network
Wireless data transmission

End-product:

❑ State-of-the-art reports on sensors development

ACTIVITY 7

Performance evaluation of structural and new repair materials

- ❖ In situ application of new repair products and systems
- ❖ Collecting data from materials performance from structures (bridges, wharves) and from the natural experimental site exposure, to fill dB-DURATI



ACTIVITY 7

Estruturas em estudo

> BARRA Bridge (Portugal)



> Ferrycarrig Bridge (Ireland)



CREATION



WEBTOOLS

WEBPLATFORM

WEBSITE

DB-DURATI & Manual web -version



OPEN to Contractors & material producers
performance systems
technical data

Private domain for project partners
Management & communication

Public Domain
Project activities/results, project events, publications final results

Database
Data on materials & repair performance and structures inspection

OPEN to Administrations
for new materials and products for repair and good experiences on their infrastructures repair activities



service life modelling

Cluster
"Smart and green materials"

Web Forum on Infrastructures Maintenance/repair

ACTIVITY 8

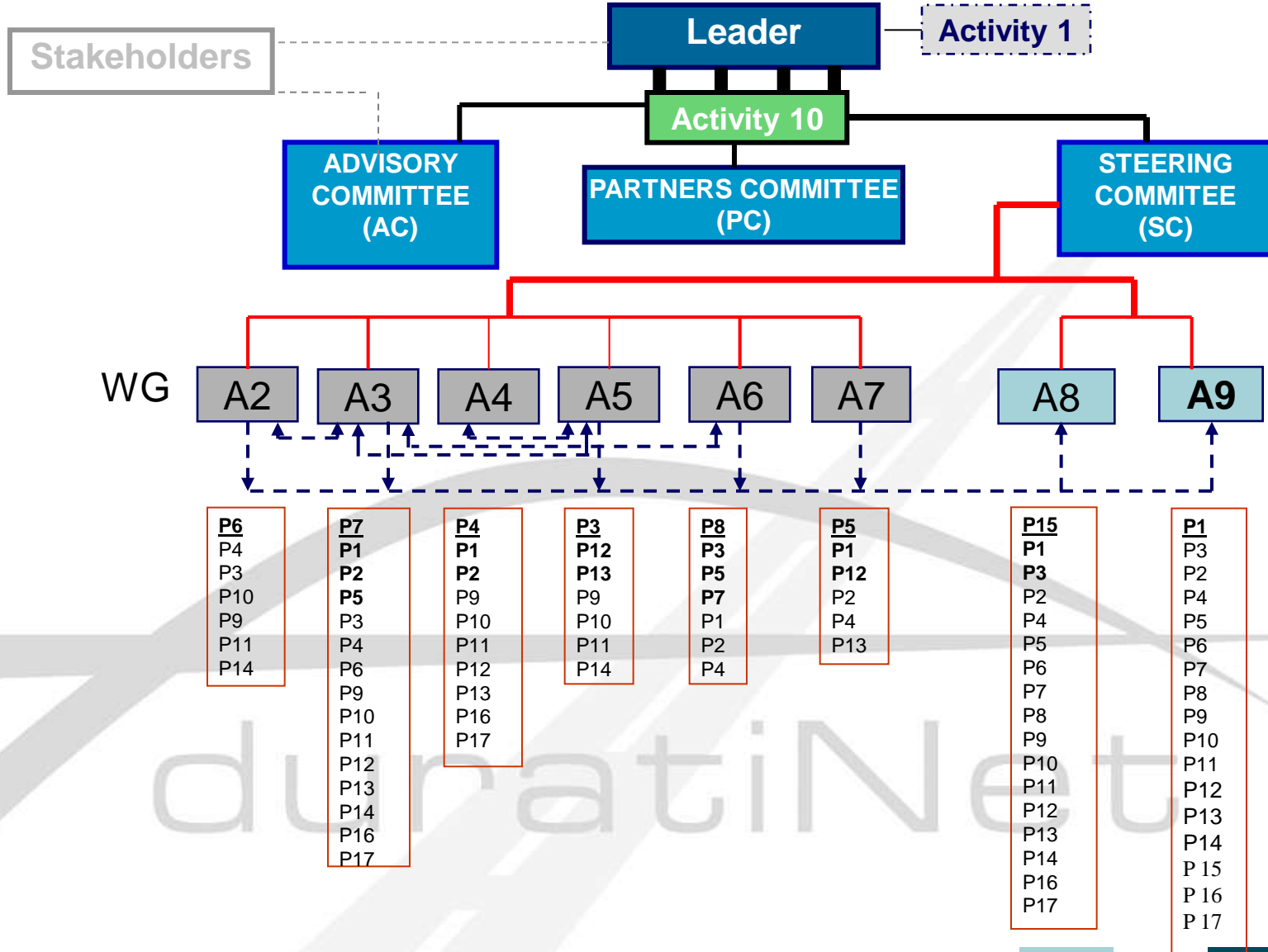
Project promotion , divulgation and dissemination actions

Organization of EVENTS for dissemination of project activities and results

> **6 Trans-national Workshops** for stakeholders and end-users (Lisbon, Belfast, Bordeaux, Dublin, Vigo, Nantes, La Rochelle)

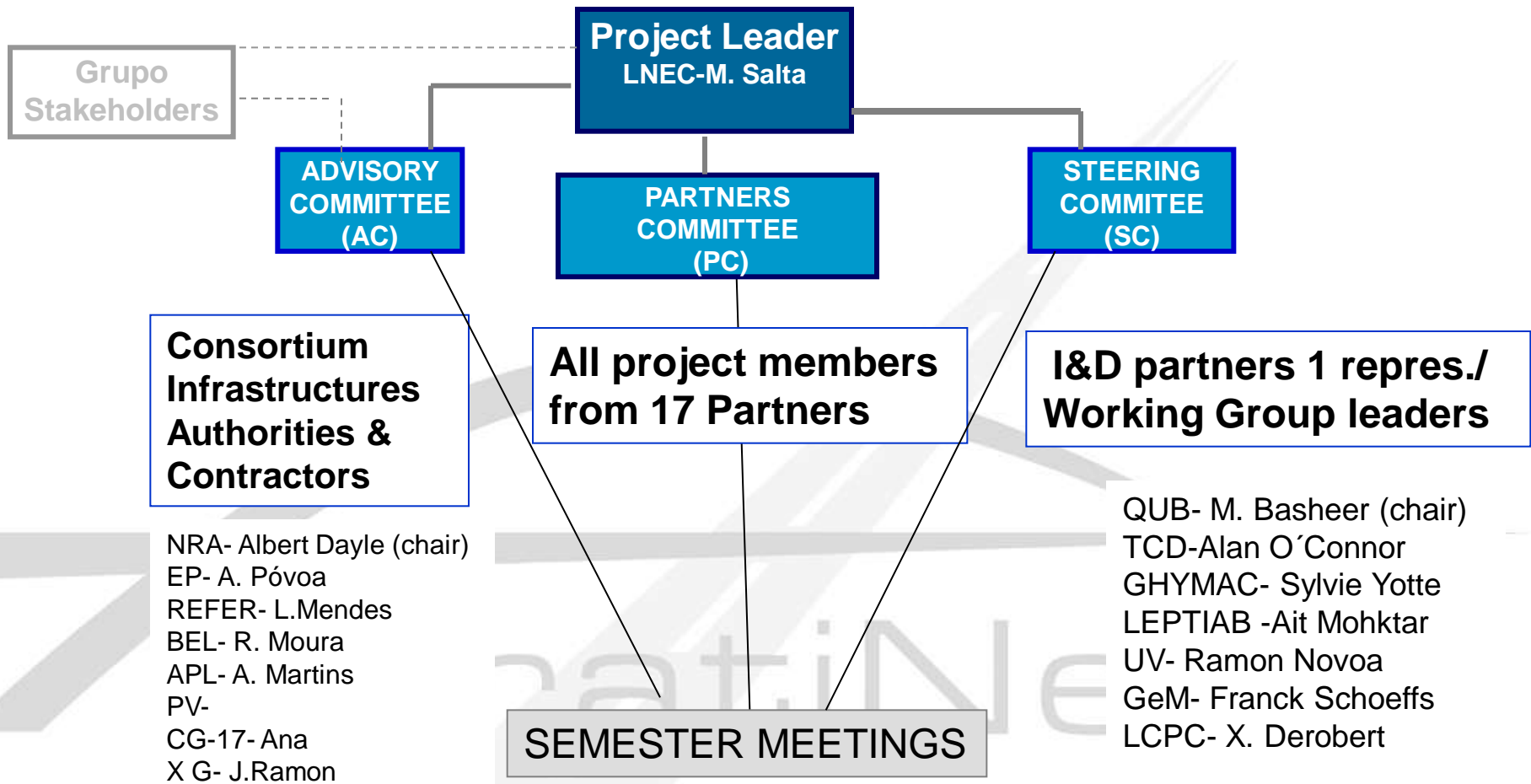
> **International Congress DURATINET** – 1st semester 2012

> **Course on inspection techniques and diagnosis** and demonstration actions on repairs –2nd semester 2011



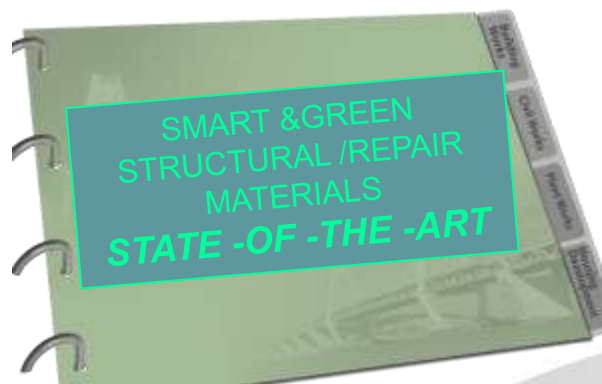
ACTIVITY 10

Activity 10

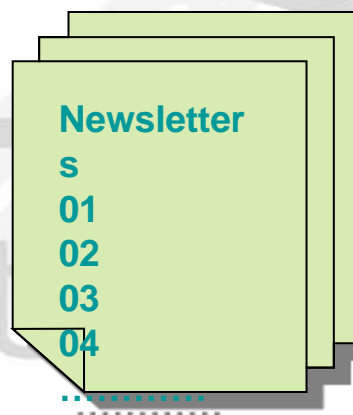


PROJECT RESULTS

➤ DIFFERENT KIND OF PUBLICATIONS

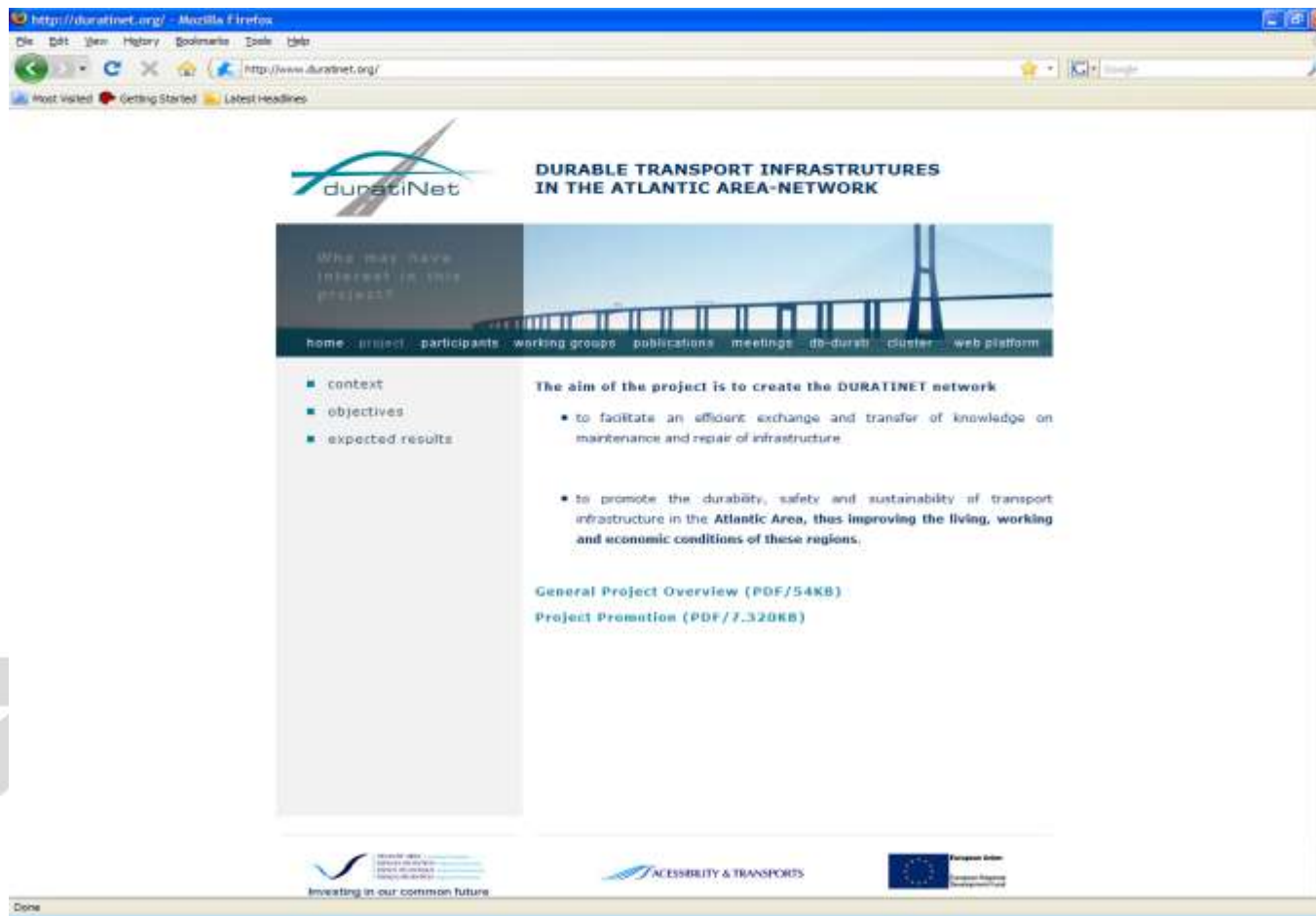


Web version
CONCRETE & STEEL
Guidelines Manual



Flyers
Posters

DURATINET WEBSITE



IN ENGLISH, PORTUGUESE, FRENCH, SPANISH

DB- DURATI

OVERVIEW
REPORT

Structures

- Bridges
 - Bridge A
 - Bridge B
 - Bridge C
 - (...)

FILTER
QUERY

GENERAL
ENVIRONMENT
MATERIAL
HISTORICAL

GENERAL INFORMATION

Country:	Portugal
Owner Manager:	x
Construction date:	y
(...)	(...)

General view

Sketch 1

Type:

Spans:

(...)

Ref. Point (x, y, z):

ENVIRONMENTAL DATA

Atmosphere

Rural	√
Urban	
Industrial	
Marine	
Marine plus industrial	

Corrosivity

C1	√
C2	
C3	
C4	
C5	

Meteorological

Atm. pollution

Water

Soil

Date:

pH	8,01
CaCO ₃ (mg/dm ³)	0
NH ₄ ⁺ (mg/dm ³)	0,7
Mg ²⁺ (mg/dm ³)	10,4
SO ₄ ²⁻ (mg/dm ³)	18,9

ME – left riverside

INSPECTION

2006/04/01

Special inspection: Beam East (VE); Beam West (VO); Abutment South (ES); Abutment North (EN); Piers P1 to P6; General observations

Images

	Elements											
	VE	VO	ES	EN	P1	P2	P3	P4	P5	P6		
Cover Thickness	x	x		x							x	x
Icorr	x	x		x							x	x
Compressive Strength	x		x	x								
Carbonation Depth	x	x	x	x	x						x	x
Chloride content			x								x	
Microscopy						x						
Mineralogy						x						x
Visual inspection	x	x	x	x	x	x	x	x	x	x	x	x

Maintenance
Repair
Monitoring

MATERIAL PROPERTIES

Material

Concrete	√
Steel	√
(...)	

Steel

Designation	x
Class	y
(...)	(...)

Chemical

Physical

Protection

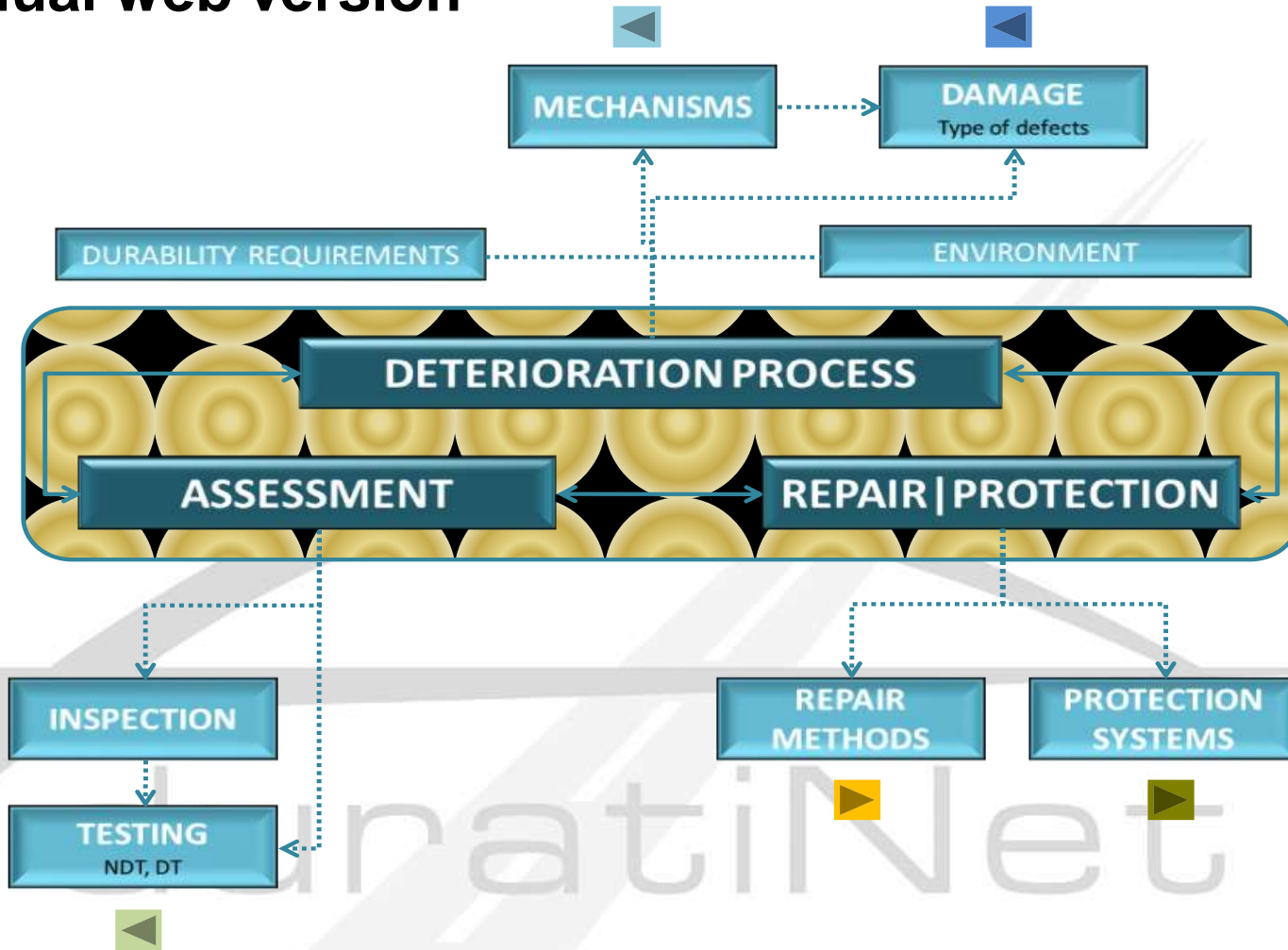
Images

C	Si	Mn	P	S	Cr	Mo	(...)
...	(...)

Microstructure



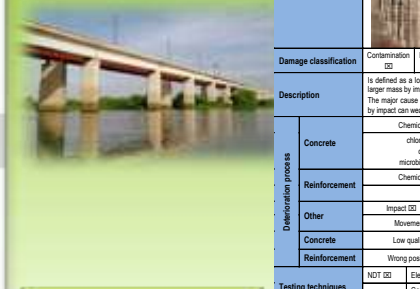
HISTORICAL – INSPECTION DATA

Manual web version






Manual web version


CONCRETE STRUCTURES

DETERIORATION PROCESS

REINFORCEMENT CORROSION



Steel embedded in concrete is protected against corrosion. Due to the high alkalinity of concrete, a spontaneous thin protective oxide film forms on the surface of the steel – the passive film. The protective action of this film can be, however, destroyed by carbonation of concrete or by the



CONCRETE STRUCTURES

TESTING TECHNIQUES

DETERMINATION OF THE CRACKING INDEX

Principle Measurement, with the help of a cracks rate and comprehensively, all the cracks that intersect four axis marked in a square of 100 cm of the surface zone of the structure in study.

Objectives Determination of the cracks overtime in-situ.

Advantages / Disadvantages Very easy to implement.

CONCRETE STRUCTURES

DEFECTS

SPALLING

Damage classification Contamination Deformation Deterioration Discontinuity Displacement Loss of material

Description It is defined as a loss of concrete cover resulting from detachment of a fragment of concrete from the larger mass by impact, by action of weather, by overstress or by expansion within the larger mass. The major cause of spalling is expansion resulting from corrosion of reinforcement. Spalling caused by impact can weaken the structure locally and also expose the reinforcement by corrosion.

Concrete chloride penetration carbonation microbiological corrosion Physical

Reinforcement Chemical & biological Physical

Other Impact Overloading Fire Vibration

Concrete Movement Explosion Water accumulation

Reinforcement Low quality Low cover Alkali-Aggregate Reaction in Concrete Structures Affected by Chloride Penetration

Testing techniques NDT Electrical resistivity DT Carbonation depth by colorimetry; Carbonation profile; Chloride penetration depth by colorimetry; Chloride profile

Repair methods Strengthening with concrete casting; Cathodic Protection; Chloride Extraction; Re-sulfation; Corrosion Inhibitors

References - ARTC – Australian Rail Track Corporation, RC 4300, Issue A; Engineering Practices Manual Civil Engineering - BRIDGE REPAIR MANUAL, Revision, march 2006.

CONCRETE





STEEL STRUCTURES

PROTECTION SYSTEMS

SURFACE PREPARATION

Description Removal of corrosion products and harmful material to the adhesion of coatings.

Generic Substrate preparation for **galv** and **anodization** of metallic structures.

Types of surface **Uncoated**, **metal-coated**, **Painted with one-fabrication system** and **other painted surfaces**

Methods **Water, solvent and chemical cleaning**, **Mechanical cleaning**, **Flame cleaning**, **Inertive cleaning**, **Hand-tool cleaning**, **Power-tool cleaning**, **Blast cleaning**

Method Type of application: **Dry abrasive**, **Wet abrasive**, **Particular applications**, **DRY ABRASIVE**

STEEL STRUCTURES

REPAIR METHODS

GRINDING

Description Grinding is the common designation given to a machining process of mechanical abrasion which uses an abrasive element as means of material removal.

Defects Small cracks, nicks and gouges; corroded surface.

Generic Fatigue improvement technique in welded structures.

Advantages / Disadvantages Essential changes in mechanical properties and microstructural characteristics.

Key aspects Limits: **Link, such as thickness and length are related to type of fatigue stress, residual and**

STEEL STRUCTURES

PROTECTION SYSTEMS

METALLIC COATINGS

Description This type of coating is composed by non-ferrous metals, such as zinc and aluminum. Metal coated surfaces may receive an organic coating resulting in a combination of systems known as **duplex systems**.

Hot Dip Galvanization

Principle Hot dipping of prepared steel or cast iron into a molten zinc bath, forming a coating of zinc and/or zinc-iron alloy.

Generic Protection against corrosion of structural elements and components.

Advantages / Disadvantages Easy control and straightforward application; premature failure rarely occurs; good abrasion resistance and thick coating on edges.

Key aspects Unattractive appearance; the size of fabrication in hot dip galvanization is limited; a low quality repair by welding; if present.

Limits Some types of cast-iron are not suitable and the adequate coating thickness is provided by the manual test.*

Control The zinc coating should be continuous with reasonable surface smoothness.*

Specific equipment Molten zinc container; lifting equipment; Protective clothing and equipment.

Sustainability **Social** Service disruption: Yes No **Health** Yes No **Environmental and health impacts** **Ecology** Yes No **Spillages of molten metal may eject from the bath at great speed** **Environment (soil) contamination** Yes No **Surface preparation** **Preliminary works** Yes No **Specialized labour** Yes No **Time consumption** Low Medium High **Posterior works** Yes No **Paint system** **Cost** Low Medium High

Standards EN ISO 14713-2:2009, EN ISO 15084:2004.

STEEL