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Contrôle, maintenance et réparation des structures en béton

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6^{ème} séminaire transnational - Nantes, juin 2011



Investing in our common future

Guide technique : Réparation et réhabilitation de structures en béton

> Livre1 : Règles de durabilité (Standards)
(resp : Queen univ. Belfast)

> Livre2 : Mécanismes et types d'endommagement
(resp : univ. La Rochelle)

Livre3 : Techniques d'inspection (destructives et non dest.)
(resp : IFSTAR)

> Livre4 : Techniques de réparation
(resp : LNEC)

> **Lien avec le site Internet : Rubriques sous forme de texte et de fiches**

Guide technique : Réparation et réhabilitation de structures en béton

> Livre1 : Rè

(resp : Q

> Livre2 : Mé

(resp : univ.

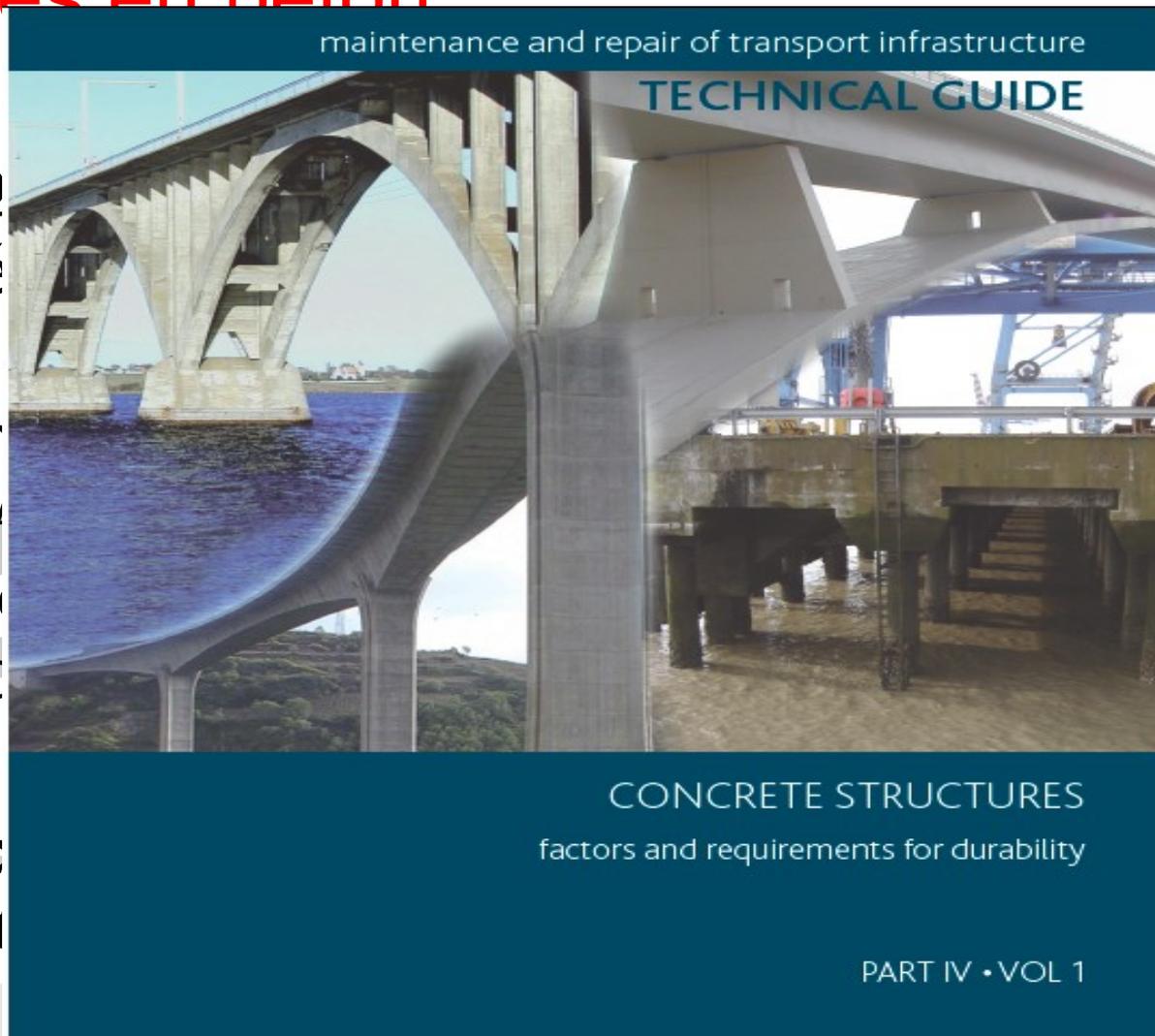
Livre3 : Tech

(resp : IFSTTA

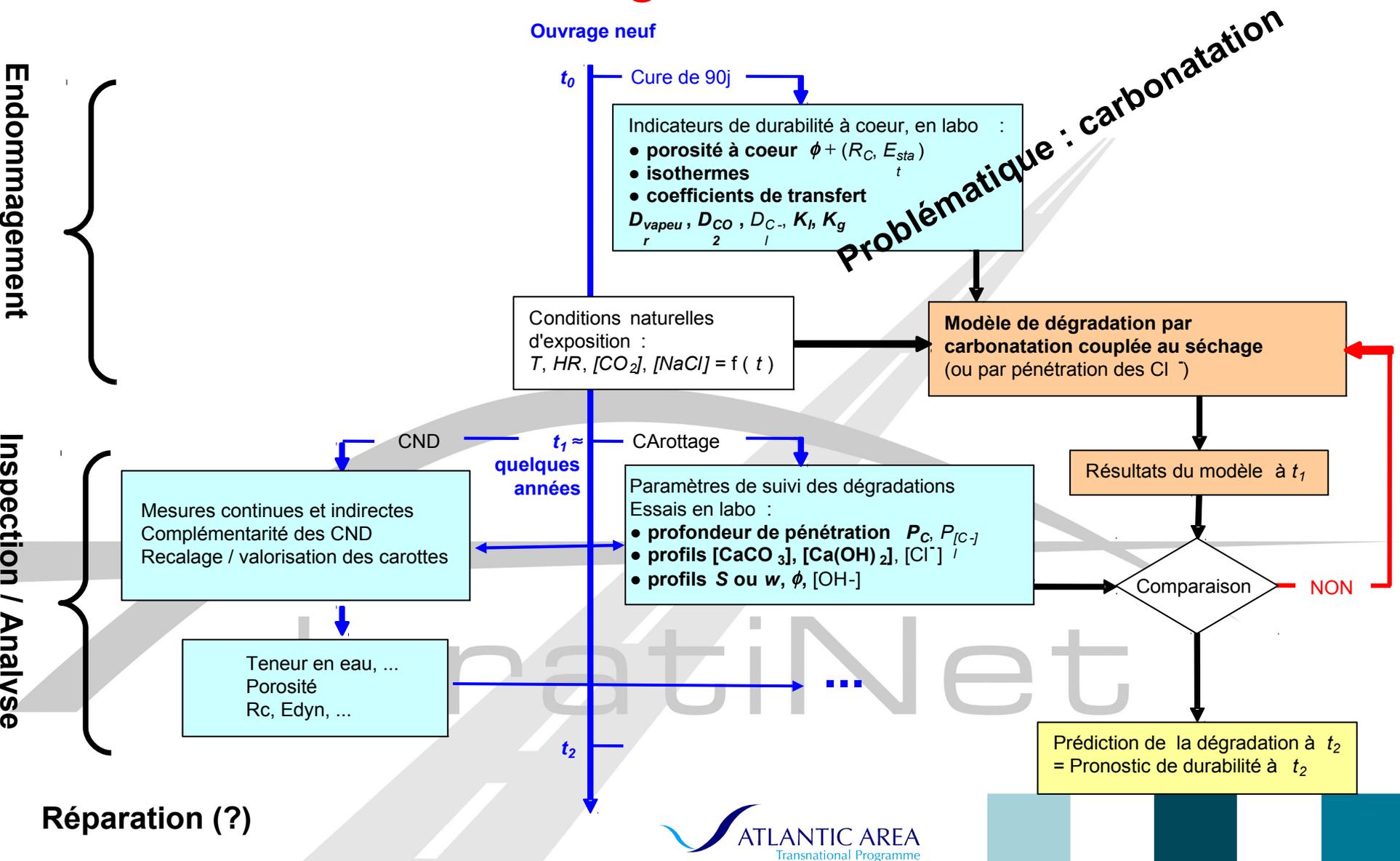
> Livre4 : Tec

(resp : LNEC

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forme de t



Durabilité des ouvrages



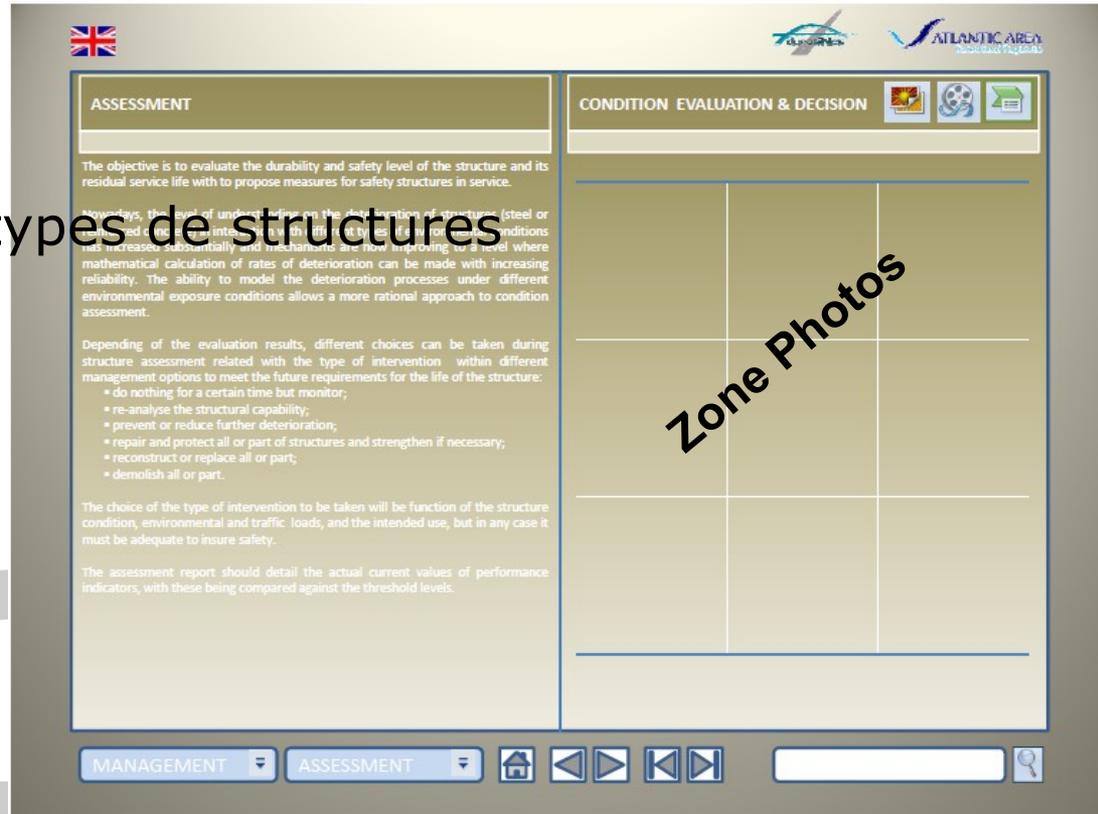
Site Internet (1/2) :

- > Combinaison Structures
En béton et en aciers
- > Résumés en plusieurs langues
- > Présentations techniques sous
Forme de fiches
- > Liens directs entre :
 - Fiches
 - Exemples (catalogues d'images)



Site Internet (2/2) :

> Partie commune aux 2 types de structures

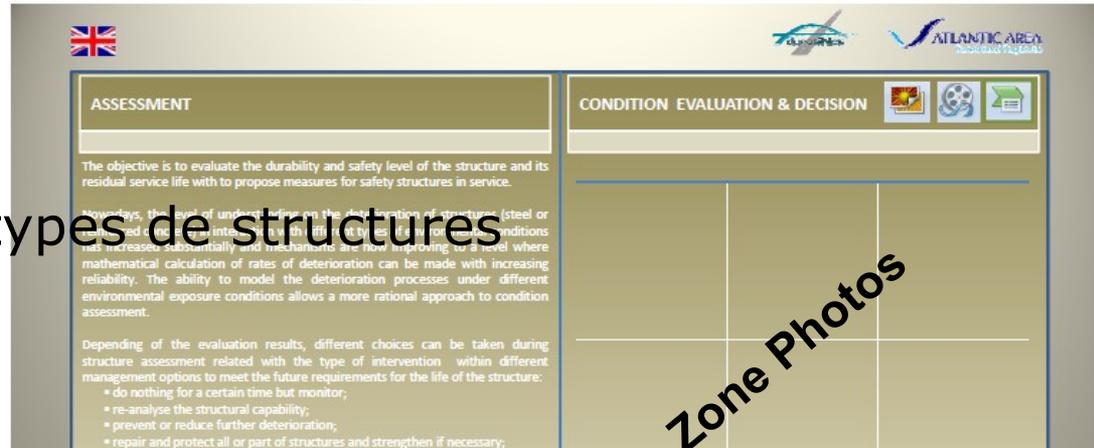


The screenshot displays the website interface for the 'ASSESSMENT' section. The page is divided into two main columns. The left column, titled 'ASSESSMENT', contains text explaining the objective of evaluating the durability and safety level of structures and their residual service life. It also discusses the evolution of assessment methods and provides a list of management options based on evaluation results. The right column, titled 'CONDITION EVALUATION & DECISION', features a large grid area labeled 'Zone Photos' and icons for document, film, and folder. The interface includes a navigation bar at the top with logos for 'duratiNet' and 'ATLANTIC AREA Transnational Programme', and a footer with 'MANAGEMENT' and 'ASSESSMENT' dropdown menus, navigation arrows, a search bar, and a magnifying glass icon.

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Site Internet (2/2) :

> Partie commune aux 2 types de structures



ASSESSMENT

The objective is to evaluate the durability and safety level of the structure and its residual service life with to propose measures for safety structures in service.

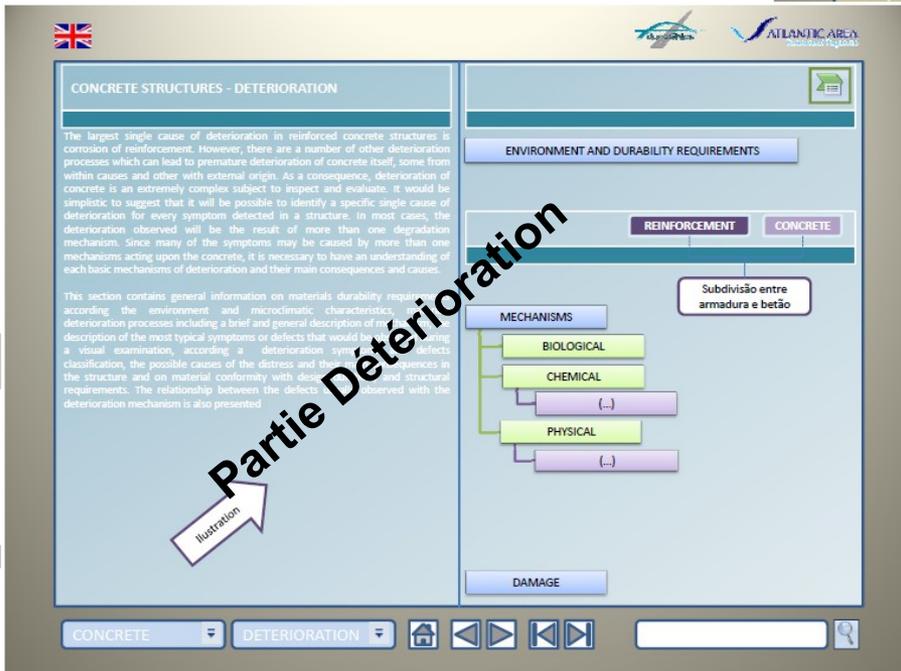
... However, the level of understanding on the deterioration of concrete (steel or concrete) and on the interaction between them in different environmental conditions has increased substantially and mechanisms are now improving to a level where mathematical calculation of rates of deterioration can be made with increasing reliability. The ability to model the deterioration processes under different environmental exposure conditions allows a more rational approach to condition assessment.

Depending of the evaluation results, different choices can be taken during structure assessment related with the type of intervention within different management options to meet the future requirements for the life of the structure:

- do nothing for a certain time but monitor;
- re-analyse the structural capability;
- prevent or reduce further deterioration;
- repair and protect all or part of structures and strengthen if necessary;

CONDITION EVALUATION & DECISION

Zone Photos



CONCRETE STRUCTURES - DETERIORATION

The largest single cause of deterioration in reinforced concrete structures is corrosion of reinforcement. However, there are a number of other deterioration processes which can lead to premature deterioration of concrete itself, some from within causes and other with external origin. As a consequence, deterioration of concrete is an extremely complex subject to inspect and evaluate. It would be simplistic to suggest that it will be possible to identify a specific single cause of deterioration for every symptom detected in a structure. In most cases, the deterioration observed will be the result of more than one degradation mechanism. Since many of the symptoms may be caused by more than one mechanism acting upon the concrete, it is necessary to have an understanding of each basic mechanisms of deterioration and their main consequences and causes.

This section contains general information on materials durability requirements according the environment and microclimatic characteristics, on deterioration processes including a brief and general description of mechanisms, a description of the most typical symptoms or defects that would be observed during a visual examination, according to a deterioration symptom classification, the possible causes of the distress and their consequences in the structure and on material conformity with design and structural requirements. The relationship between the defects observed with the deterioration mechanism is also presented

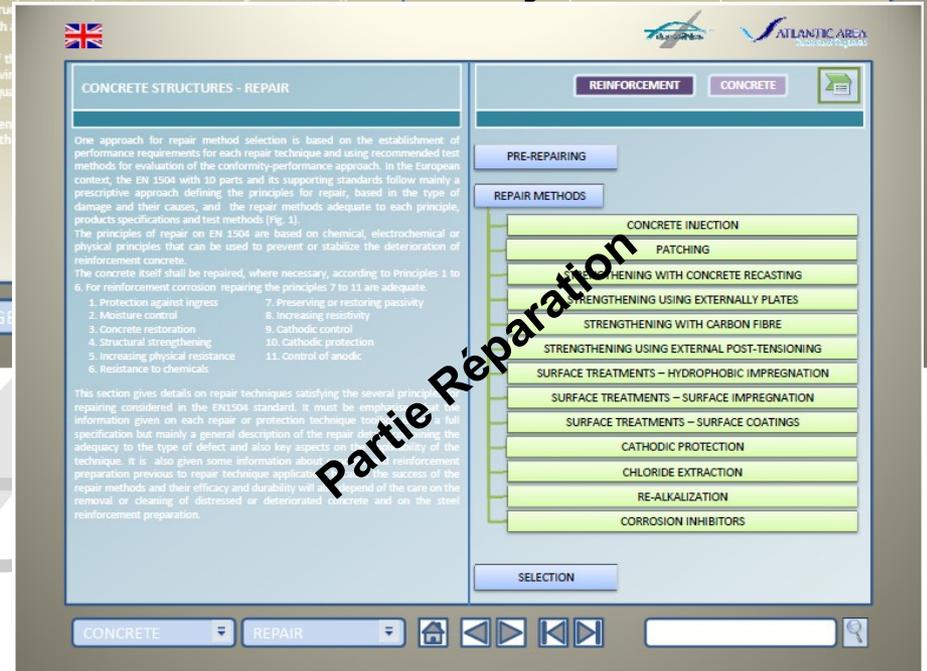
Subdivisão entre armadura e betão

MECHANISMS

- BIOLOGICAL
- CHEMICAL
- (...)
- PHYSICAL
- (...)

DAMAGE

Partie Détérioration



CONCRETE STRUCTURES - REPAIR

One approach for repair method selection is based on the establishment of performance requirements for each repair technique and using recommended test methods for evaluation of the conformity-performance approach. In the European context, the EN 1504 with 10 parts and its supporting standards follow mainly a prescriptive approach defining the principles for repair, based in the type of damage and their causes, and the repair methods adequate to each principle, products specifications and test methods (Fig. 1).

The principles of repair on EN 1504 are based on chemical, electrochemical or physical principles that can be used to prevent or stabilize the deterioration of reinforcement concrete.

The concrete itself shall be repaired, where necessary, according to Principles 1 to 6. For reinforcement corrosion repairing the principles 7 to 11 are adequate.

1. Protection against ingress
2. Moisture control
3. Concrete restoration
4. Structural strengthening
5. Increasing physical resistance
6. Resistance to chemicals
7. Preserving or restoring passivity
8. Increasing resistivity
9. Cathodic control
10. Cathodic protection
11. Control of anodic

This section gives details on repair techniques satisfying the several principles repairing considered in the EN1504 standard. It must be emphasized that the information given on each repair or protection technique too general and full specification but mainly a general description of the repair details, ensuring the adequacy to the type of defect and also key aspects on the applicability of the technique. It is also given some information about the reinforcement preparation previous to repair technique application. The success of the repair methods and their efficacy and durability will depend of the care on the removal or cleaning of distressed or deteriorated concrete and on the steel reinforcement preparation.

REINFORCEMENT CONCRETE

PRE-REPAIRING

REPAIR METHODS

- CONCRETE INJECTION
- PATCHING
- STRENGTHENING WITH CONCRETE RECASTING
- STRENGTHENING USING EXTERNALLY PLATES
- STRENGTHENING WITH CARBON FIBRE
- STRENGTHENING USING EXTERNAL POST-TENSIONING
- SURFACE TREATMENTS – HYDROPHOBIC IMPREGNATION
- SURFACE TREATMENTS – SURFACE IMPREGNATION
- SURFACE TREATMENTS – SURFACE COATINGS
- CATHODIC PROTECTION
- CHLORIDE EXTRACTION
- RE-ALKALIZATION
- CORROSION INHIBITORS

SELECTION

Partie Réparation

Fiches techniques / Chapitres de texte

> Livre 3 « Techniques d'inspections » :

- Site Internet : 36 fiches techniques
- Livre :
 - *Par familles de techniques (Non destructives / Destructives)*
 - *Applications / Principe / Mesures et interprétation / points clés / R&D / Références (2-4 pages)*
- Techniques d'inspections non destructives (in-situ)
- Techniques d'inspections destructives (analyses)

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Fiches techniques / Chapitres de texte

CONCRETE STRUCTURES		TESTING TECHNIQUES		
COVER DEPTH (COVERMETER)				
Principle	The measurement is based on ferromagnetic induction principles. To detect the localization, size and depth of reinforcements the equipments induce "eddy-currents" to flow around the circumference of the bar, producing a magnetic field. This field of the device picks up the magnetic signal and pulse techniques separate this signal from the transmitted one. Therefore, no signal is produced in the absence of a metallic material. A distinct maximum in induced current is observed when the long axis of the probe and reinforcement are aligned and when the probe is directly above the reinforcement.			
Objectives	To detect the localization and depth of reinforcements. Some equipment also allows to estimate steel diameter if previous calibration is performed. Covermeter surveys need to be correlated with other information from the investigation, including defect mapping, carbonation depths and chloride profiles.			
Objectives and Applicability	Deterioration process(es)	Defect(s)	Control of repair	
	Corrosion reinforcement	Steel loss	Concrete replacement Strengthening : adding New	
Equipment and availability	Severely deteriorated	Health	Preliminary works	
Destructive feature	In situ	Economical	Time consumption	
		Cost	Access to the element	
Advantages	Sampling	Type of samples	Dimension	
		Extraction	Transport	
Key aspects	Accurate	Limit	Example of application	
				Material
Social	Service under development	References	 Typical Application	
Environmental and	Health	References	BS 1881-204:1988 - Testing concrete. Recommendations on the use of electromagnetic covermeters. Malhotra V.M. and Carino, N.J. Concrete - Handbook on Non Destructive Testing of Concrete. CRC Press, second edition, 2004, pp. 386.	

* depending from the structures extension

CONCRETE STRUCTURES		REPAIR METHODS	
SURFACE TREATMENTS			
Description	Hydrophobic (Impregnation)	Surface Impregnation	Surface Coating
	This is a concrete treatment to prevent the ingress of aggressive species promoting concrete deterioration by chemical or some physical processes or corrosion of reinforcements which can be also included in a repair system of concrete structures. This treatment involves the application of a product with low viscosity liquid with active components: organic polymers, latexes, epoxies, polyurethanes or solvent based silicates, sodium and potassium fluoride. The product is easily absorbed, used to partially fill the pores resulting in a discontinuous thin film (usually 10-100 µm) on the surface, that reduces the surface porosity of concrete and increases the surface strength. Can be designed to harden concrete surfaces increasing their wear resistance and limit penetration by aggressive agents.		
Applicability	Defect(s): - If deterioration concrete the application of the previous injection on concrete damage (Penetration) could exclude previous treatment.		
Key aspects	Advantages	Durability	Limitations
	Disadvantages	Control of repair	Penetration is required before applying in the case of the treatment. CR-1504-2 systems for complex with requirements sealing can be pull-off testing strength.
Specific equipment	Adequate for product application		
Sustainability	Social	Service disruption	Yes/No
	Environmental and health impacts	Health	Yes/No
Key aspects	Limits	Ecology	Yes/No
		Preliminary work Specialized labour Time consumption Posterior work	Yes/No Yes/No Low/High Yes/No
Control of repair	At reception the properties and characteristics of the injection materials must be fulfilled within the admissible tolerances. The control of workmanship must be performed by the supervisor monitoring the injection and approved using a NDT procedure.		
Techniques	SEALING - HIM	SEALING - PIM	

EX. de réparation

Perspectives

- > Relectures : finalisation
- > Impression : automne 2011
- > Diffusion / Information : fin 2011 – début 2012
 - Workshop final (~ mai 2012 à Lisbonne)

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