Guidance for repair/rehabilitation of concrete transport infrastructures (CTIS)

Activity Lead Partner

Queen's University Belfast, Northern Ireland, UK

European Union European Regional Development Fund

Investing in our common future

ATLANTIC AREA Transnational Programme

Aim of the Activity

To make a critical review concerning the main subjects involved in CTIS repair, damage and assessment and repair techniques

- Exposure variations
- Types of structures
- Causes of deterioration
- Material degradation models
- Impact of degradation on performance
- Decision on time of intervention
- Establishment of performance requirements
- Repair strategy – methods and materials
- Assessment of repair performance

Aim of the Activity

To make a critical review concerning the main subjects involved in CTIS repair, damage and assessment and repair techniques

- Exposure variations
- Types of structures
- Causes of deterioration
- Material degradation models
- Impact of degradation on performance
- Decision on time of intervention
- Establishment of performance requirements
- Repair strategy – methods and materials
- Assessment of repair performance

duratiNet
2nd Transnational Workshop
QUB, Belfast 22nd June 2009

Exposure Classes in EN 206

- No risk of corrosion
- Carbonation-induced corrosion
- Chloride-induced corrosion resulting primarily from de-icing salts
- Chloride-induced corrosion resulting from seawater exposure
- Freeze-thaw attack
- Chemical attack

duratiNet
ATLANTIC AREA Transnational Programme

Exposure Classes in EN 206

Class	Environment	Examples
1. No risk of corrosion or attack		
X0	Concrete with no embedded metal (except where there is freeze/thaw, abrasion or chemical attack) For concrete with reinforcement or embedded metal: very dry	Concrete inside buildings with very low air humidity.
2. Corrosion induced by carbonation		
XC1	Dry or permanently wet	Concrete inside buildings with low air humidity Concrete permanently submerged in water
XC2	Wet, rarely dry	Concrete surfaces subject to long-term water contact Many foundations
XC3	Moderate humidity	Concrete inside buildings with moderate or high air humidity, External concrete sheltered from rain
XC4	Cyclic wet and dry	Concrete surfaces subject to water contact, not within exposure class XC2

duratiNet
2nd Transnational Workshop
QUB, Belfast 22nd June 2009

Exposure Classes in EN 206

3. Corrosion induced by chlorides other than from seawater		
XD1	Moderate humidity	Concrete surfaces exposed to airborne chlorides
XD2	Wet, rarely dry	Swimming pools, Concrete exposed to industrial water containing chlorides
XD3	Cyclic wet and dry	Parts of bridges exposed to spray containing chlorides Pavements, Car park slabs
4. Corrosion induced by chlorides from seawater		
XS1	Exposed to airborne salt but not in direct contact with seawater	Structures near to or on the coast
XS2	Permanently submerged	Parts of marine structures
XS3	Tidal, splash and spry zones	Parts of marine structures

Exposure Classes in EN 206

5. Freeze/thaw attack with or without de-icing agents		
XF1	Moderate water saturation, without de-icing agent	Vertical concrete surfaces exposed to rain and freezing
XF2	Moderate water saturation, with de-icing agent	Vertical concrete surfaces of road structures exposed to freezing and airborne de-icing agents
XF3	High water saturation, without de-icing agent	Horizontal concrete surfaces exposed to rain and freezing
XF4	High water saturation, with de-icing agent or seawater	Road and bridge decks exposed to direct spray containing de-icing agents and freezing. Splash zones of marine structures exposed to freezing.
6. Chemical attack		
Where concrete is exposed to chemical attack from natural soils and ground water is given in Table 3, the exposure shall be classified as given below. The classification of seawater depends on the geographical location; therefore the classification is valid in the place of use of the concrete.		
XA1	Slightly aggressive chemical environment according to Table 3	
XA2	Moderately aggressive chemical environment according to Table 3	
XA3	Highly aggressive chemical environment according to Table 3	

duratiNet 2nd Transnational Workshop
QUB, Belfast 22nd June 2009

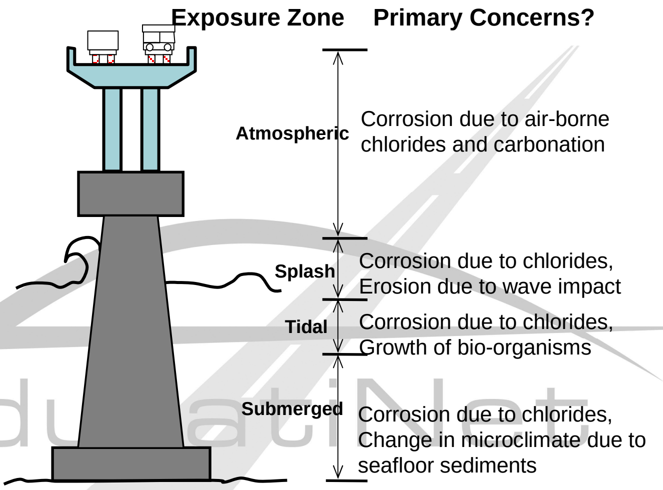
Aim of the Activity

To make a critical review concerning the main subjects involved in CTIS repair, damage and assessment and repair techniques

- Exposure variations
- **Types of structures**
- Causes of deterioration
- Material degradation models
- Impact of degradation on performance
- Decision on time of intervention
- Establishment of performance requirements
- Repair strategy – methods and materials
- Assessment of repair performance

ATLANTIC AREA Transnational Programme

Types of Structure



duratiNet
2nd Transnational Workshop
QUB, Belfast 22nd June 2009

Aim of the Activity

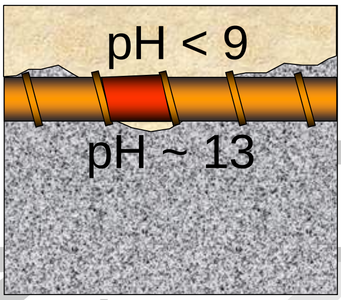
To make a critical review concerning the main subjects involved in CTIS repair, damage and assessment and repair techniques

- Exposure variations
- Types of structures
- **Causes of deterioration**
- Material degradation models
- Impact of degradation on performance
- Decision on time of intervention
- Establishment of performance requirements
- Repair strategy – methods and materials
- Assessment of repair performance

ATLANTIC AREA Transnational Programme

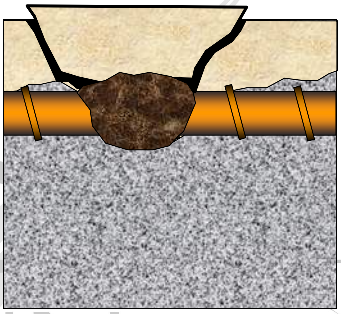
Corrosion of steel reinforcement

Loss of passivity



Advance of carbonation or chloride front

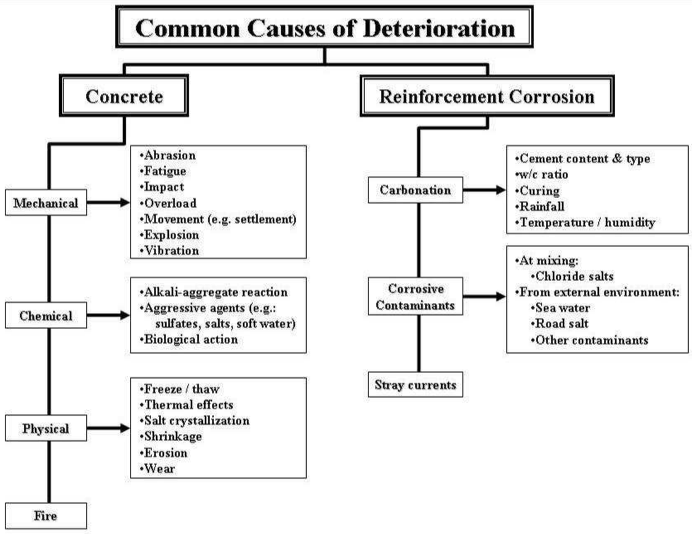
Formation of rust



Expansion of steel due to corrosion

Freeze-Thaw Damage

Causes of Deterioration

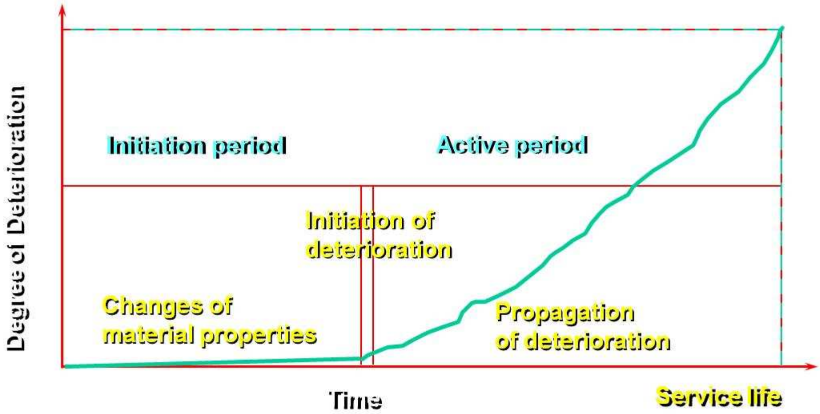


Aim of the Activity

To make a critical review concerning the main subjects involved in CTIS repair, damage and assessment and repair techniques

- Exposure variations
- Types of structures
- Causes of deterioration
- Material degradation models
- Impact of degradation on performance
- Decision on time of intervention
- Establishment of performance requirements
- Repair strategy – methods and materials
- Assessment of repair performance

Degradation models and impact of degradation on structural performance



duratiNet
2nd Transnational Workshop
QUB, Belfast 22nd June 2009

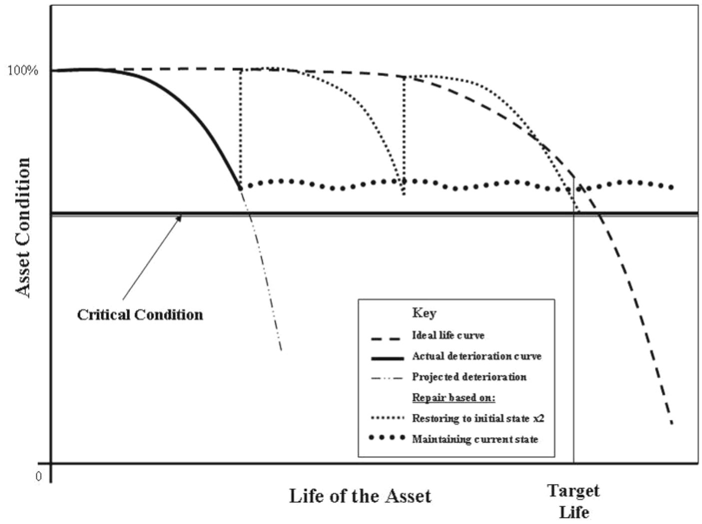
Aim of the Activity

To make a critical review concerning the main subjects involved in CTIS repair, damage and assessment and repair techniques

- Exposure variations
- Types of structures
- Causes of deterioration
- Material degradation models
- Impact of degradation on performance
- **Decision on time of intervention**
- Establishment of performance requirements
- Repair strategy – methods and materials
- Assessment of repair performance

ATLANTIC AREA
Transnational Programme

Decision on Time of Intervention



Aim of the Activity

To make a critical review concerning the main subjects involved in CTIS repair, damage and assessment and repair techniques

- Exposure variations
- Types of structures
- Causes of deterioration
- Material degradation models
- Impact of degradation on performance
- Decision on time of intervention
- Establishment of performance requirements
- Repair strategy – methods and materials
- Assessment of repair performance

durati**Net**

2nd Transnational Workshop
QUB, Belfast 22nd June 2009

Repair Strategies

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

duratiNet

ATLANTIC AREA
Transnational Programme

durati**Net**

2nd Transnational Workshop
QUB, Belfast 22nd June 2009

Aim of the Activity

To make a critical review concerning the main subjects involved in CTIS repair, damage and assessment and repair techniques

- Exposure variations
- Types of structures
- Causes of deterioration
- Material degradation models
- Impact of degradation on performance
- Decision on time of intervention
- Establishment of performance requirements
- Repair strategy – methods and materials
- Assessment of repair performance

duratiNet

ATLANTIC AREA
Transnational Programme

Activities

- Review of requirements of concrete durability
  - Task Leader: QUB
- Mechanism and types of damage in reinforced concrete
  - Task Leader: U. La Rochelle
- In situ inspection techniques – specifications and comparisons
  - Task Leader: U. Bordeaux
- Repair techniques for concrete structures
  - Task Leader: LNEC

QUB contributes also to Activity 6 - Smart structural materials with permanent monitoring systems in concrete

duratiNet
2nd Transnational Workshop
QUB, Belfast 22nd June 2009

Thank You

duratiNet

ATLANTIC AREA
Transnational Programme