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ACCESSIBILITY & TRANSPORTS

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**7th Trans-national Workshop**

Lisboa • LNEC • 30<sup>th</sup> May 2012


**Part III: Degradation, Inspection and Maintenance of Steel Structures**

maintenance and repair of transport infrastructure


**TECHNICAL GUIDE**      **STEEL STRUCTURES**

**PART III**


**Franck Schoefs, LUNAM Université, U. of Nantes, France**  
**and all the partners of WG4 (LNEC, REFER, IFSTTAR)**



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Volume 1. 44 pages					
Part III – Steel structures: Vol. 1					
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Table 4. Atmospheric corrosivity categories, respective corrosion rates of carbon steel for the first year of exposure and examples of typical environments. (Adapted from [4] and [5])					
Category	Corrosivity	Corrosion rate of carbon steel		Examples of typical environments in a temperate climate (only informative)	
		g/m <sup>2</sup>	µm	Exterior	Interior
C <sub>1</sub>	Very low	≤ 10	≤ 1.3		Heated buildings with clean atmospheres
C <sub>2</sub>	Low	> 10 to 200	> 1.3 to 25	Atmospheres with low level of corrosion. Mostly rural areas.	Unheated buildings where condensation may occur.
C <sub>3</sub>	Medium	> 200 to 400	> 25 to 50	Urban and industrial atmospheres with moderate sulphur dioxide pollution. Coastal area with low salinity.	Production rooms with high humidity and some air pollution.
C <sub>4</sub>	High	> 400 to 650	> 50 to 80	Industrial and coastal areas with moderate salinity.	Chemical plants, swimming pools, coastal, ship and boatyards.
C <sub>5</sub>	Very high	> 650 to 1500	> 80 to 200	Industrial areas with high humidity and aggressive atmosphere.	Buildings or areas with almost permanent condensation and high pollution.

ISO 9223:1992 <sup>(1)</sup> and EN ISO

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Table 2. Defect types and corresponding deterioration processes.

		Deterioration processes					
		Chemical and Biological		Physical	Other events		
		Corrosion	Accumulation of debris and dirt	Fatigue	Impact	Overloading	Fire
							Water accumulation
Defect type	Contamination	■	■				■
	Deformation				■	■	■
	Deterioration	■		■		■	■
	Discontinuity	■		■		■	■
	Displacement		■		■	■	■
	Loss of material	■		■	■	■	■

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PART III  
STEEL STRUCTURES  
VOL. 2  
deterioration

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Fig. 24. Illustration of uniform corrosion in steel structural elements with significant or total section loss.

Fig. 25. Illustration of pitting corrosion in a steel structural element.

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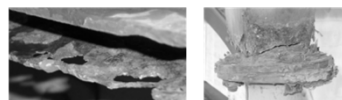


Fig. 24. Illustration of uniform corrosion in steel structural elements with significant or total section loss.




Fig. 25. Illustration of pitting corrosion in a steel structural element.

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# Volume 3. 74 pages

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**TECHNICAL GUIDE**

**PART III**  
**STEEL STRUCTURES**  
**Vol. 3**  
**testing techniques**

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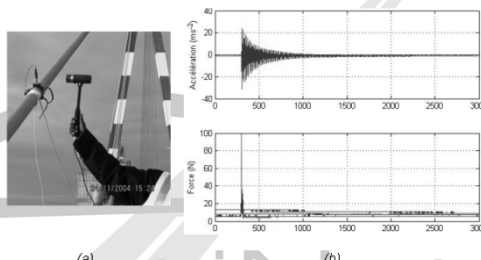
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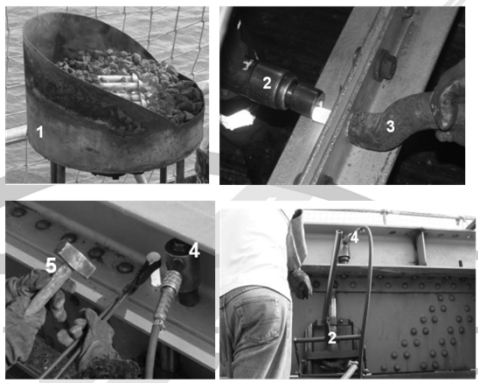
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		5 similar sub-sections			
Authors: Laurent Gaillet Principal researcher, IFSTTAR Hugo Pemeta Duratinet research fellow, LNEC  Other contributions: Maria João Correia Postdoctoral fellow, LNEC Maria Manuela Salta Principal researcher and head of Metallic Materials Division, LNEC  Reviewers: Anténio Baptista Principal researcher, LNEC Hugo Patricio		Application field Specific principle <u>Test procedure and results interpretation</u> Key aspects Applications under development ATLANTIC AREA International Programme Investing in our common future European Union European Regional Development Fund			

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		Fig. 19. Riveting in situ: 1. portable forger; 2. pneumatic hammer with an adapted tool; 3. rivet snap; 4. small hydraulic jack; 5. hand hammer.			
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PART III STEEL STRUCTURES (V.L. 5) protection systems					
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Table 4. Typical characteristics of impressed current anodes. (Adapted from [3] and [4])

Anode material	Consumption rates g/A year	Maximum current density A m <sup>-2</sup>	Maximum voltage V
High-silicon cast iron alloys	100 to 500	10 to 50	50
Mixed-metal oxide	0.0006 to 0.006	35 to 1000 <sup>(c)</sup>	8 <sup>(b)</sup>
Platinised titanium	0.0012 to 0.004 <sup>(a)</sup>	500 to 3000	8 <sup>(b)</sup>
Platinised niobium	0.0012 to 0.004 <sup>(a)</sup>	500 to 3000	50
Platinised tantalum	0.0012 to 0.004 <sup>(a)</sup>	500 to 3000	100
Lead silver	25 to 100	250 to 300	24

The life of the platinum film may be affected by the electrolyte resistivity, and by the magnitude and frequency of the ripple present in the d.c. supply.

In sea water, the oxide film on titanium may break down with voltages exceeding 8 V. Higher voltages may be used with fully platinised or in less saline environments.

Typical values in freshwater range from 35 to 50 A m<sup>-2</sup>, in soil are about 100 A m<sup>-2</sup>, and in seawater are higher.

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(V.L. 5)  
protection systems

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