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Project nr 2008-1/049

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7th Trans-national Workshop

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Part III: Degradation, Inspection and Maintenance of Steel Structures

maintenance and repair of transport infrastructure

TECHNICAL GUIDE

PART III

STEEL STRUCTURES

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

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maintenance and repair of transport infrastructure
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PART III
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durability factors and requirements

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deterioration

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PART III
STEEL STRUCTURES
VOL. 5
protection systems

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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 [1] and [5])*

Category	Corrosivity	Corrosion rate of carbon steel		Examples of typical environments in a temperate climate (only informative)	
		g/m²	µm	Exterior	Interior
C_1	Very low	≤ 10	≤ 1.3	-	Heated buildings with clean atmospheres
C_2	Low	> 10 to 200	> 1.3 to 25	Atmospheres with low level of corrosion. Mostly rural areas.	Unheated buildings where condensation may occur.
C_3	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_4	High	> 400 to 650	> 50 to 80	Industrial and coastal areas with moderate salinity.	Chemical plants, swimming pools, coastal, ship and boatyards.
$C_{5\text{-}I}$	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 [1] and EN ISO

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Table 2. Defect types and corresponding deterioration processes.

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

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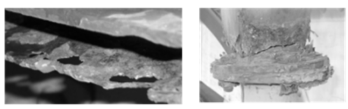

Fig. 24. Illustration of uniform corrosion in steel structural elements with significant or total section loss.

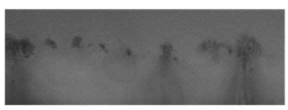

Fig. 25. Illustration of pitting corrosion in a steel structural element.

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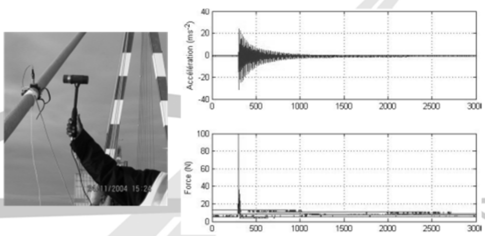

(a) (b)

Fig. 12. (a) Stay cable inspection by the technique and (b) recorded waveform and deduced tension in the cable.

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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; 4. hand hammer.

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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⁻²	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 c)	8 b)
Platinised titanium	0.0012 to 0.004 a)	500 to 3000	8 b)
Platinised niobium	0.0012 to 0.004 a)	500 to 3000	50
Platinised tantalum	0.0012 to 0.004 a)	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 Am⁻², in soil are about 100 Am⁻², and in seawater are higher.


Fig. 8. Water blast cleaning