INSPECTION METHODOLOGIES

Authors: Prof. Inês Flores (translation) and Prof. Jorge de Brito

Coordination: Prof. F.A. Branco, Prof. Jorge de Brito, Prof. Pedro Vaz Paulo and Prof. João Pedro Correia
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3. STRATEGY OF INSPECTION
4. INSPECTION AND DIAGNOSTIC SYSTEMS
5. CONCLUSIONS

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1. INTRODUCTION
1. INTRODUCTION

The inspections are intended principally to maintain the habitability / functionality and security of the buildings during their lifetime.

The service life of a building (or a building element) is the period of time after construction, during which all properties exceed the minimum acceptable values, assuming the existence of periodic maintenance actions.
The conduct of inspections must meet technical criteria, with standardized procedures, suitable to the construction type.

Reasons for performing inspections:
- identify potential problems;
- monitor to avoid possible damages;
- identify areas in need of preventive maintenance;
- evaluate the performance of building elements and construction.
2. INSPECTION TYPES

CLASSIFICATION:

Inspections can be classified as:

- element type / construction to be inspected;
- inspection rigor level: visual, type of equipment used, type of in-situ tests or laboratory;
- urgency degrees: critical (imminent health and security risk, unserviceable), regular (in functionality risk, subject to maintenance) or minimum (risk of early devaluation);
- periodicity: periodic (current and detailed) and non-periodic (structural evaluation and initial characterization of construction).

Aspects will be developed with the frequency and level of rigor of inspections.
2. INSPECTION TYPES

Periodic inspections according to BS 8210:

- **regular observation** by the user during the use of the building;
- **annual visual inspection** of key elements under the supervision of qualified personnel;
- **general inspection** of the entire building every 5 years, by qualified personnel.

*Bureau Veritas* recommends local inspections every 3-5 years to check the occurrence of anomalies and in-service behavior, and global inspections every 10 or 15 years to examine possible dysfunctions and real aging of all elements.
2. INSPECTION TYPES

a) Current inspections:

Allow evaluating the evolution of surface anomalies and monitor the process of the previously identified;

Characteristics of current inspections:
- direct visual observation;
- frequency: 15 months;
- *impromptu* or partial visits;
- planning and simple means of access;
- team with at least one experienced technician;
- portable equipment easy to use.

Anomaly correctly referenced and with a well-defined scale
2. INSPECTION TYPES

a) Current inspections (cont.):

Routine maintenance during the inspection: vegetation removal, cleaning of the drainage system, touch-up painting, among others...

Parasitic vegetation
b) Detailed Inspections:

- through a general observation of construction, allow a good knowledge of the surface defects, cracking, deterioration of materials, deformations of structure and of drainage system.
Characteristics of detailed inspections:

- visual observation (*check-up of the construction*);
- frequency: 5 years;
- nondestructive in-situ testing;
- preliminary visit;
- laboratory testing (if essential);
- access means (simple and specials);
- team with a specialist engineer.

Routine maintenance during the inspection: vegetation removal, cleaning of the drainage system, touch-up painting, among others...
2. INSPECTION TYPES

c) Inspections for structural assessment:

- special inspections, non-periodic, result on the detection of severe structural or functional anomaly; have a specialized character, often being confined to a restricted part of the building structure and in this, to a specific phenomenon; usually precede to a reinforcing or a widening of the usage type;

- generally involve tests to characterize the building.

Defective concrete cover
Characteristics of inspections for structural assessment:

- highly detailed, but confined;
- by definition, non-periodic;
- with preliminary visits;
- in-situ tests and laboratory;
- support of monitoring;
- special means of access;
- specialized equipment;
- specialized team.

Exposed bars in a concrete column
2. INSPECTION TYPES

d) Initial characterization of the construction:

- reference state which involves the set of structural and functional features of construction.

Characteristics:
- non-periodic inspection;
- immediately after the construction (final acceptance);
- in the implementation of the inspection system;
- after major interventions;
- nondestructive testing in-situ;
- special means of access;
- specialized team;
- generally associated with the reception of the construction work.
CHAPTER 3

STRATEGY OF INSPECTION
3. STRATEGY OF INSPECTION

a) Inspection methodology:

- the methodology to be followed must be simultaneously feasible, expeditious, effective and likely to produce useful information for the subsequent stages of maintenance and repair.

Inspection procedure:

- collection and analysis of documentation;
- preparation of inspections;
- observation checklist;
- inspection support means;
- diagnostic methodology;
- inspection report.
3. STRATEGY OF INSPECTION

b) Collection and analysis of the documentation:

- survey of the largest possible number of “clues” to acknowledge the problem – site visit and consultation of administrative and technical documentation (design files, warranty term, inspection and previous repairs reports, technical reports, interventions reports, among others).
c) Preparation of inspections:

- inspections must obey to a predetermined schedule to enable a proactive building maintenance, optimize resources and costs;

- should be assessed, in advance, interior and exterior building conditions (entry requirements, security issues, local conditions, among others.);

- whenever possible, should be included in the planning simple routine maintenance actions to be carried out along with the inspections.
3. STRATEGY OF INSPECTION

d) Observation checklist:

- the pathological diagnosis should be objective and cover all components and equipment subject to visual inspection;

- the list should include the type of inspection to be carried out, the manifestation forms of expected degradation, the severity of anomalies detected, among others.

(Brand, 1994)
3. STRATEGY OF INSPECTION

Identify the elements to be inspected by direct observation of the exterior of the building
3. STRATEGY OF INSPECTION

Elements to be inspected according to the figure:

1) roof (deformations, entry of rain water,…);
2) structure condition (broken elements, settlements, corrosion, exposed rebar,…);
3) condition of the roof cladding (broken or missing tiles,…);
4) gutters (drainage, cleanliness,…);
5) run-off areas (poor construction details);
6) rakes (emerging elements in the roof,…);
3. STRATEGY OF INSPECTION

7) areas with parasitic vegetation;
8) areas with moisture stains;
9) cracked areas;
10) render condition;
11) frames condition (glass, structure,…);
12) surrounding area (protective coating condition, moisture,…);
13) flower beds and adjacent areas;
14) vents.
3. STRATEGY OF INSPECTION

Symbol
Identification of the anomaly
Identification of elements

(BRE, 1995)

Water infiltration

(Flores-Colen & Brito, 2006)

Standard symbols for illustrating rendering defects (see BS 5262)
e) Inspection support means:

- portable equipment: pencils, pens, chalk, rulers, measuring tape, crack ruler, hammer, flashlight, camera, etc.;

- auxiliary access means (ladder, vehicle to transport inspectors, suspended steel platform (right figure), among others;

- design elements, inspection manual, inspection checklist, notepad, among others.
### 3. STRATEGY OF INSPECTION

**e) Inspection support means:**

(Flores-Colen, 2009)

<table>
<thead>
<tr>
<th>Inspection Support Means</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Molhagem dos paramentos (avaliação da existência de fissuras ou de pulverulência)</td>
<td>Observação com lupa ampliação 3x ou microscópio 30x (estado da superfície)</td>
</tr>
<tr>
<td>Punção</td>
<td>Percussão com martelo de borracha para avaliar qualitativamente a aderência ao suporte</td>
</tr>
<tr>
<td>Escovagem para avaliar fixação da sujidade</td>
<td>Variação de cor (sistema NCS)</td>
</tr>
</tbody>
</table>
### 3. STRATEGY OF INSPECTION

e) Inspection support means :  
(Flores-Colen, 2009)

<table>
<thead>
<tr>
<th>Method</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Microscópio óptico (quantificação da abertura média da fissuração e microfissuração)</td>
<td>Escovagem para avaliar as eflorescências</td>
</tr>
<tr>
<td>Profundidade de carbonatação</td>
<td></td>
</tr>
</tbody>
</table>

- **Microscópio óptico**
  - Quantificação da abertura média da fissuração e microfissuração.

- **Escovagem**
  - Para avaliar as eflorescências.

- **Profundidade de carbonatação**
  - Para determinar a profundidade de carbonatação na superfície.

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**ASTM D4610 - 98(2013)**

*Standard Guide for Determining the Presence of and Removing Microbial (Fungal or Algal) Growth on Paint and Related Coatings*
e) Inspection support means:

Various types of access systems, both permanent and temporary
(Chew and Ping, 2003)

Permanent access system:
1: trolley unit
2: mono rail system
3: traversing trolley
4: personal units
5: fixed davits;
6: travelling ladders.

Temporary access system:
7: counterweight suspended beam;
8: parapet clamps:
9: scaffolding;
10. booms.
f) Diagnostic methodology:

- complete understanding of the occurred phenomena – analysis of cause-effect relations, which usually characterize a pathological problem - understanding the "why" and "how" of available data;

**Diagnostic methodology procedure:**
- observation / verification;
- description and characterization of the anomaly;
- anomaly classification;
- testing (in-situ or laboratory);
- monitoring possible damage;
- identifying cause(s);
- identifying solutions and control the outcome;
- prognosis of the situation.
3. STRATEGY OF INSPECTION

**g) Inspection report** (non-exhaustive topics list):

- **framework data** *(historical / social aspects, building characteristics, building solutions, conservation condition of components and systems, among others)*;

- **description of inspection** *(methodology followed, means used, weather conditions, inspected elements, anomalies observed, local constraints, performed maintenance actions, among others)*;

- **analysis and diagnosis of anomalies** *(nature of anomalies, extent, severity, probable causes, likely consequences for its evolution, among others)*;
3. STRATEGY OF INSPECTION

- recommendations and priorities (repairs, structural reinforcement, testing, monitoring, detailed inspection, etc.), identifying necessary means and objectives to be achieved in terms of final performance;

- attachments (designs, photographs, diagrams, among others).

Simplified designs/schemes of the construction (when there are no parts of the design) that allow support for the inspection, clearly locating any detected anomalies.
## CHAPTER 4

### INSPECTION AND DIAGNOSTIC SYSTEMS
4. INSPECTION AND DIAGNOSTIC SYSTEMS

Inspection and diagnostic systems ease:

- storage of information gathered through the work file and a database;
- standardization of procedures and inspections reports and maintenance / repair / strengthening / replacement;
- decision making at the level of maintenance, inspection strategy and selection of rehabilitation / replacement work.

General architecture of the management system (Brito, 1992)
4. INSPECTION AND DIAGNOSTIC SYSTEMS

General operation of the inspection system:

Legenda:

- Inspection
- Base elements for each type of inspection
- Results of each inspection that are used and / or stored

(Brito, 1992)
a) Classification system:

- ANOMALIES
  - ANOMALY SHEETS
- POSSIBLE CAUSES
- DIAGNOSIS METHODS
  - SHEETS OF METHODS
- REPAIR TECHNIQUES
  - SHEETS OF REPAIR

[Brito, 2010]
4. INSPECTION AND DIAGNOSTIC SYSTEMS

CLASSIFICATION OF ANOMALIES

• Surface anomalies;
• Exhaustive but without repetitions;
• Logical organization;
• Rating criteria: visual aspect, cause or location?
• Simple is beautiful;
• Visual observation without recourse to in situ testing.

Classificatory system of inspection
### 4. INSPECTION AND DIAGNOSTIC SYSTEMS

**CLADDING IN NATURAL STONE**

<table>
<thead>
<tr>
<th>GRUPOS</th>
<th>SUB-GRUPOS</th>
<th>DESCRIÇÃO DA MANIFESTAÇÃO</th>
</tr>
</thead>
<tbody>
<tr>
<td>A-A</td>
<td>A-A1</td>
<td>Alteração cromática — Mancha ou diferença de tonalidade</td>
</tr>
<tr>
<td>A-F</td>
<td>A-F1</td>
<td>Fracturação</td>
</tr>
<tr>
<td>A-Fi</td>
<td>A-Fi2</td>
<td>Lascagem do material pétreo nas zonas de orifícios de fixação e/ou corrosão dos elementos metálicos de fixação</td>
</tr>
<tr>
<td>A-JU</td>
<td>A-JU1</td>
<td>Fendilhação ou fractura dos elementos Pétreos na proximidade das juntas</td>
</tr>
<tr>
<td>A-JU</td>
<td>A-JU2</td>
<td>Ausência de linearidade ou dimensões adequadas nas juntas</td>
</tr>
<tr>
<td>A-Fi</td>
<td>A-Fi1</td>
<td>Flexão e rotura dos elementos metálicos de fixação</td>
</tr>
<tr>
<td>A-P</td>
<td>A-P1</td>
<td>Diminuição volumétrica do material pétreo — destaque laminar, desgaste, desagregação granular, pulverização picadura, alveolização</td>
</tr>
<tr>
<td>A-P</td>
<td>A-P2</td>
<td>Alteração ou deposição — depósito superficial, eflorescência, película, concreção, incrustação e crosta</td>
</tr>
<tr>
<td>A-P</td>
<td>A-P3</td>
<td>Lacuna parcial do elemento pétreo</td>
</tr>
<tr>
<td>A-DE</td>
<td>A-DE1</td>
<td>Descolamento do elemento pétreo — parcial ou total</td>
</tr>
<tr>
<td>A-DE</td>
<td>A-DE2</td>
<td>Desprendimento do elemento pétreo — parcial ou total</td>
</tr>
<tr>
<td>A-DE</td>
<td>A-DE3</td>
<td>Deficiências de planeza na superfície do revestimento</td>
</tr>
<tr>
<td>A-AJU</td>
<td>A-AJU1</td>
<td>Degradação ou perda do material de refechamento das juntas — parcial ou total</td>
</tr>
<tr>
<td>A-AJU</td>
<td>A-AJU2</td>
<td>Ausência de linearidade ou dimensões adequadas nas juntas</td>
</tr>
<tr>
<td>A-P</td>
<td>A-P1</td>
<td>Diminuição volumétrica do material pétreo — destaque laminar, desgaste, desagregação granular, pulverização picadura, alveolização</td>
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<td>A-P</td>
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<td>Alteração ou deposição — depósito superficial, eflorescência, película, concreção, incrustação e crosta</td>
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<td>A-P3</td>
<td>Lacuna parcial do elemento pétreo</td>
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<td>Desprendimento do elemento pétreo — parcial ou total</td>
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<tr>
<td>A-DE</td>
<td>A-DE3</td>
<td>Deficiências de planeza na superfície do revestimento</td>
</tr>
</tbody>
</table>

(Brito, 2010)
4. INSPECTION AND DIAGNOSTIC SYSTEMS

CLASSIFICATION OF POSSIBLE CAUSES OF THE ANOMALIES

- Chronological organization;
- Design / material selection phase;
- Implementation phase;
- Usage phase (human and environmental factors).

Classificatory system of inspection
## 4. INSPECTION AND DIAGNOSTIC SYSTEMS

### Sistema classificativo das causas

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>a)</td>
<td>Erros de projecto</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>b)</td>
<td>Erros de execução</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>c)</td>
<td>Acções de origem mecânica exterior</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>d)</td>
<td>Acções ambientais</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>e)</td>
<td>Falhas de manutenção</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>f)</td>
<td>Alteração das condições iniciais</td>
</tr>
</tbody>
</table>

(Brito, 2010)
### Anomaly sheet (example):

<table>
<thead>
<tr>
<th>ANOMALY SHEET (EXAMPLE)</th>
</tr>
</thead>
<tbody>
<tr>
<td>TYPE: REBAR / CABLES</td>
</tr>
<tr>
<td>SHEET: A-D5</td>
</tr>
<tr>
<td>NAME: bar with decreased section</td>
</tr>
<tr>
<td>DESCRIPTION: exposed ordinary rebar by spalling of the concrete cover and showing loss of cross section</td>
</tr>
<tr>
<td>CAUSES: -spalling caused by shock (C-D2)</td>
</tr>
<tr>
<td>POSSIBLE: -carbonation (C-F2, C-G2)</td>
</tr>
<tr>
<td>-rebar corrosion</td>
</tr>
<tr>
<td>-presence of chloride ions (C-F3, C-G3, C-B6)</td>
</tr>
<tr>
<td>-insufficient concrete cover (C-A14, C-B11, C-A28, C-B1, C-B2, C-B26)</td>
</tr>
<tr>
<td>-excessively exposed areas / inappropriate geometric design (C-A20)</td>
</tr>
<tr>
<td>-poor drainage (C-A24, C-A23, C-A25, C-B20, C-B26, C-H5)</td>
</tr>
<tr>
<td>-water infiltration (poor sealing) (C-F1, C-G1, C-A26, C-B5, C-B9, C-B17, C-E2, C-E3, C-E4)</td>
</tr>
<tr>
<td>POSSIBLE CONSEQUENCES:</td>
</tr>
<tr>
<td>-progressive spalling of the concrete due to the increase in volume of the rust</td>
</tr>
<tr>
<td>-cracking</td>
</tr>
<tr>
<td>-loss of resistance of the section</td>
</tr>
<tr>
<td>-loss of adherence of the bar</td>
</tr>
<tr>
<td>-structure deflection</td>
</tr>
<tr>
<td>-affected aesthetic</td>
</tr>
</tbody>
</table>

(Brito, 1992)
### Anomaly sheet (cont.): (Brito, 1992)

| ASPECTS TO INSPECT: | - black rust color: (probable origin: chlorine ions => larger sections loss) or reddish rust color (probable origin: carbonation => least danger)  
|                     | - corrosion condition of neighboring bars  
|                     | - adherence of the cover  
|                     | - carbonation, presence of chloride ions, water seepage  
|                     | - watertightness condition  
|                     | - cracking in the observed area  
|                     | - deformations  
|                     | - condition of the drainage system  
|                     | - sea proximity  
|                     | - usage in the present or in the past of antifreeze salts  
| PARAMETERS OF INSPECTION: | - predominant color of rust: black (Y / N) / red (Y / N)  
|                     | - location of the section with bar loss: area of maximum effort (Y/N) intermediate areas (Y / N)  
|                     | - maximum localized loss of section: ( % )  

#### CLASSIFICATION OF ANOMALY:

**In terms of Urgency of Operation**

- **0** - predominantly black rust in area(s) of maximum effort with maximum localized loss of upper section to x %  
- **1** - predominantly black rust in area(s) of maximum effort with maximum localized loss of bottom section x%  
- **2** - predominantly black rust in intermediate zones  
- **3** - predominantly red rust  

**In terms of importance for the Stability of the Structure**

- **A** – bar belonging to the deck bridge, main beams, columns, abutments and foundations  
- **C** – bar belonging to the guard rails, wheelguards, coating of the sidewalk and transition slabs  

**In terms of the Traffic Volume Affected by Anomaly**

- **g** - assuming that this anomaly does not disturb the normal operation of traffic
Diagnostic methods:

In-situ and laboratory tests with the objectives of:

- characterizing the building;
- characterizing the degradation phenomena;
- characterizing the environmental conditions.
CLASSIFICATION OF DIAGNOSTIC TECHNIQUES

- Techniques / testing *in situ*;
- Support for visual observation;
- Quick, inexpensive techniques with reliable, easy to interpret and useful results (qualitatively and quantitatively) with portable equipment without external sources of energy, without skilled labor, with non-destructive nature and not disturbing for users;
- Rating criteria: *principle of operation*, type of anomaly, location?
### Proposed Classification of In Situ Diagnosis Methods of Anomalies in RPN

<table>
<thead>
<tr>
<th>Code</th>
<th>Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>M-V</td>
<td>Assisted Visual Analysis</td>
</tr>
<tr>
<td>M-C</td>
<td>Color techniques</td>
</tr>
<tr>
<td>M-U</td>
<td>Ultrasonic techniques</td>
</tr>
<tr>
<td>M-T</td>
<td>Thermal methods</td>
</tr>
<tr>
<td>M-A</td>
<td>Acoustic techniques</td>
</tr>
<tr>
<td>M-F</td>
<td>Strength techniques</td>
</tr>
<tr>
<td>M-H</td>
<td>Moisture methods</td>
</tr>
</tbody>
</table>

Examples of subgroups of diagnostic methods from the proposed listing:

- **M-V2** - Crack meter
- **M-V4** - Endoscopy
- **M-F1** - Pull-off

SHEETS OF DIAGNOSTIC METHOD

- Description of the technique;
- Objectives;
- Required equipment / materials;
- Description of the method;
- Advantages;
- Limitations.
### 4. INSPECTION AND DIAGNOSTIC SYSTEMS

<table>
<thead>
<tr>
<th>Código do ensaio</th>
<th>M-A1</th>
<th>M-A2</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Designação</strong></td>
<td>Fissurómetro</td>
<td>Medicação da inclinação de RCA</td>
</tr>
<tr>
<td><strong>Destrutivo (D) / não destrutivo (ND)</strong></td>
<td>ND</td>
<td>ND</td>
</tr>
<tr>
<td><strong>Técnica / material necessário</strong></td>
<td>Fissurómetro ou régua de fendas</td>
<td>clinómetro de bola de ar (tipo Hugerleberger)</td>
</tr>
<tr>
<td><strong>Necessidades especiais</strong></td>
<td>acesso directo ao local de ocorrência da anomalia</td>
<td>-</td>
</tr>
<tr>
<td><strong>Vantagens</strong></td>
<td>equipamento de baixo custo e reduzida exigência técnica</td>
<td>verificar a ocorrência ou a progressão de anomalias; confirmar a adequabilidade da inclinação à drenagem da água (em pavimentos)</td>
</tr>
<tr>
<td><strong>Limitações</strong></td>
<td>-</td>
<td>inexistência de inclinações uniformes no RCA, sendo por isso necessário recorrer à análise por amostragem</td>
</tr>
<tr>
<td><strong>Modo de execução</strong></td>
<td>leitura directa da largura de fissuras ou fendas verificadas em RCA; registo dos valores observados e execução do mapeamento com a localização, gravidade e orientação da anomalia</td>
<td>colocação do clinómetro na horizontal / vertical sobre a superfície do RCA de pavimento / parede; leitura directa no equipamento do valor da inclinação</td>
</tr>
<tr>
<td><strong>Objectivo</strong></td>
<td>medir a largura de fissuras ou fendas verificadas em RCA</td>
<td>verificar a inclinação, em %, de um RCA de pavimento ou de parede</td>
</tr>
</tbody>
</table>

*(Brito, 2010)*

**CLADDING IN ADHESIVE CERAMICS**
4. INSPECTION AND DIAGNOSTIC SYSTEMS

Criteria for assessment of diagnostic methods:

A - lower costs;
B - easy and quick to use *in situ*;
C - lots of useful information;
D - easy interpretation of results;
E - non-destructive nature;
F - portable equipment;
G - no need of any power source (or easily accessible energy *in situ*);
H - manpower and knowledge not overly specialized;
I - reliability of results;
J - (whenever possible) absence of laboratory work;
K - no (or little) obstacle to the normal functioning of the bridge.
4. INSPECTION AND DIAGNOSTIC SYSTEMS

<table>
<thead>
<tr>
<th>Técnica T1</th>
<th>Técnica T2</th>
<th>Técnica T3</th>
<th>Técnica T4</th>
</tr>
</thead>
<tbody>
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</tr>
</tbody>
</table>

4.4.1 Técnicas de inspeção e diagnóstico

4.4.1.1 Técnicas de inspeção e diagnóstico usadas:

- Técnicas T1, T2, T3, T4, T5, T6, T7, T8, T9, T10, T11, T12, T13, T14, T15, T16.

4.4.1.2 Legenda dos critérios de inspeção e diagnóstico:

- C1: boa credibilidade e segurança do equipamento.
- C2: utilização fácil rápida e do equipamento.
- C3: avaliação de qualidade de conformidade.
- C4: fácil interpretação de resultados.
- C5: inspeção por equipamento portátil.
- C6: usados para testes de in-situ.
- C7: tanta que a recolha de amostras é necessária.
- C8: sem ter獨立 access ao laboratório.

4.4.2 Descrição dos valores adoptados

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<th>Critério</th>
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4.4.3 Técnicas que são usadas:

- Técnicas T1, T2, T3, T4.

4.4.4 Técnicas que não são usadas:

- Técnicas T5, T6, T7, T8, T9, T10, T11, T12, T13, T14, T15, T16.

4.4.5 Legenda dos valores:

- Técnica T1: tecnica não-destructiva, técnica de análise rápida.
- Técnica T2: tecnica semi-destructiva, com a necessidade de pequenas reparações.
- Técnica T3: tecnica de avaliação por equipamento portátil.
- Técnica T4: tecnica de avaliação por equipamento portátil.

4.4.6 Legenda das técnicas:

- Técnica T1: tecnica de avaliação por equipamento portátil.
- Técnica T2: tecnica de avaliação por equipamento portátil.
- Técnica T3: tecnica de avaliação por equipamento portátil.
- Técnica T4: tecnica de avaliação por equipamento portátil.

4.4.7 Legenda das tarefas:

- Tarefa T1: tarefa de análise rápida.
- Tarefa T2: tarefa de análise rápida.
- Tarefa T3: tarefa de análise rápida.
- Tarefa T4: tarefa de análise rápida.

4.4.8 Legenda das técnicas:

- Técnica T1: tecnica não-destructiva, com a necessidade de pequenas reparações.
- Técnica T2: tecnica semi-destructiva, com a necessidade de pequenas reparações.
- Técnica T3: tecnica de avaliação por equipamento portátil.
- Técnica T4: tecnica de avaliação por equipamento portátil.

4.4.9 Legenda das tarefas:

- Tarefa T1: tarefa de análise rápida.
- Tarefa T2: tarefa de análise rápida.
- Tarefa T3: tarefa de análise rápida.
- Tarefa T4: tarefa de análise rápida.
4. INSPECTION AND DIAGNOSTIC SYSTEMS

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Score:
- 2 – if the technique fulfills the criterion;
- 1 – if the technique completely fails the criterion;
- 0 – if the technique does not fulfill the criterion.

Flores-Colen et al., 2006
b) Correlation matrices:

In order to assist the diagnosis made by the inspector on site, a set of correlation matrices of the anomalies detected during the inspection should be created.

(Brito, 1992)

Correlation matrices that compose the management system
### 4. Inspection and Diagnostic Systems

**Sample correlation matrix (anomalies – possible causes)**

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**0 – NO RELATION** - there is no correlation (direct or indirect) between the anomaly and the cause;

**1 - LITTLE CORRELATION** - indirect cause (first) of the anomaly related only to the first steps of the process of deterioration; secondary cause of the deterioration process not required for their development;

**2 - BIG CORRELATION** - direct cause (close) of the anomaly associated with the final stage of the deterioration process; when the cause occurs, is a major cause of the deterioration process and is essential to its development.

(Brito, 1992)
4. INSPECTION AND DIAGNOSTIC SYSTEMS

Correlation between anomalies - repair techniques:

0 - NO RELATION  there is no correlation (direct or indirect) between the anomaly and repair technique;
1 - LITTLE CORRELATION - preventive technique of removing the cause or causes of the anomaly but not of deterioration;
2 - BIG CORRELATION - curative technique of eliminating deterioration in the area where the anomaly was detected.

Correlation between anomalies - diagnostic methods:

0 - NO RELATION  - there is no correlation (direct or indirect) between the anomaly and the method of diagnosis;
1 - LITTLE CORRELATION - the diagnostic method may prove useful as a second choice of a method with high correlation when this can not be done or provides inconclusive results; can also be helpful to provide some secondary data about the extent and cause of the anomaly;
2 - BIG CORRELATION - the diagnostic method is, in principle, necessary for the inspection of the anomaly; provides essential information about the extent, severity and cause of the anomaly.
4. INSPECTION AND DIAGNOSTIC SYSTEMS

(c) Module to support the inspection:

The correlation matrices form the backbone of the inspection support module (ISM) and can also aid in the selection of maintenance and repair work to perform and that is in the services.

(Brito, 1992)
4. INSPECTION AND DIAGNOSTIC SYSTEMS

Repair Sheet (example):  
(Brito, 1992)

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**6 - DESCRIPTION OF THE WORK**

6.1 - Removal of the deteriorated material
6.2 – Placement of the reinforcement bar
6.3 - Filling the cavity
6.4 - Injection of cracks
6.5 - Sealing / Waterproofing
6.6 - Repaving
6.7 - Fire protection
6.8 - Surface leveling
6.9 - Rubble removal
6.10 - Others

**7 - REQUIRED STAFF**

**8 - REQUIRED EQUIPMENT**
4. INSPECTION AND DIAGNOSTIC SYSTEMS

Repair Sheet (example), cont.:

9 - ESTIMATED EFFICIENCY
9.1 - functionality
9.2 - mechanical
10 - SPECIAL PROBLEMS
10.1 - Elimination of the causes of anomalies
10.2 - Contraindications
10.3 - Special Care
10.4 - Advantages and disadvantages
10.5 - Other Reviews
11 - COSTS
ANEXO 1 - SCHEMES
ANEXO 2 - SECONDARY SHEETS
4. INSPECTION AND DIAGNOSTIC SYSTEMS

EXAMPLE: Inspection Sheet for concrete structure in buildings (attached to the inspection report)

<table>
<thead>
<tr>
<th>Identification of the building.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Characterization of reinforced concrete elements:</td>
</tr>
<tr>
<td>Sketch with location of anomalies.</td>
</tr>
<tr>
<td>Assessment of the state of degradation of various elements:</td>
</tr>
<tr>
<td>Columns, beams, slabs, elements of exposed concrete, stairs, among other.</td>
</tr>
<tr>
<td>Conclusions and observations.</td>
</tr>
<tr>
<td>Date of next inspection.</td>
</tr>
</tbody>
</table>
FURTHER READING

Inspection and diagnosis systems for coatings and claddings


CHAPTER 5

MODULE CONCLUSIONS
5. CONCLUSIONS

. Inspections should ensure the functionality of buildings throughout their service life and extend this as much as possible.

. The conduct of inspections must meet technical criteria, with standardized and suitable procedures to the type of construction.

. Inspections should provide objective and unambiguous information.

. In a proactive maintenance strategy, inspections shall be conducted with a pre-defined schedule and cover all elements / components and equipment in need of maintenance actions.

. The implementation of an inspection and diagnosis system facilitates the storage of the collected information, the standardization of procedures and reports for inspection and decision making.
BIBLIOGRAPHY

Publications in descending chronological order


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• BRITO, de Jorge (2001), “Metodologias de Inspecção”, Seminar of Inspection and Maintenance of Bridges (FUNDEC), Lisboa

• CASTRO, E. K. (1994), " Desenvolvimento de metodologia para manutenção de estruturas de concreto armado", Dissertation, University of Brasília, Brasília, DF, 185p, December
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