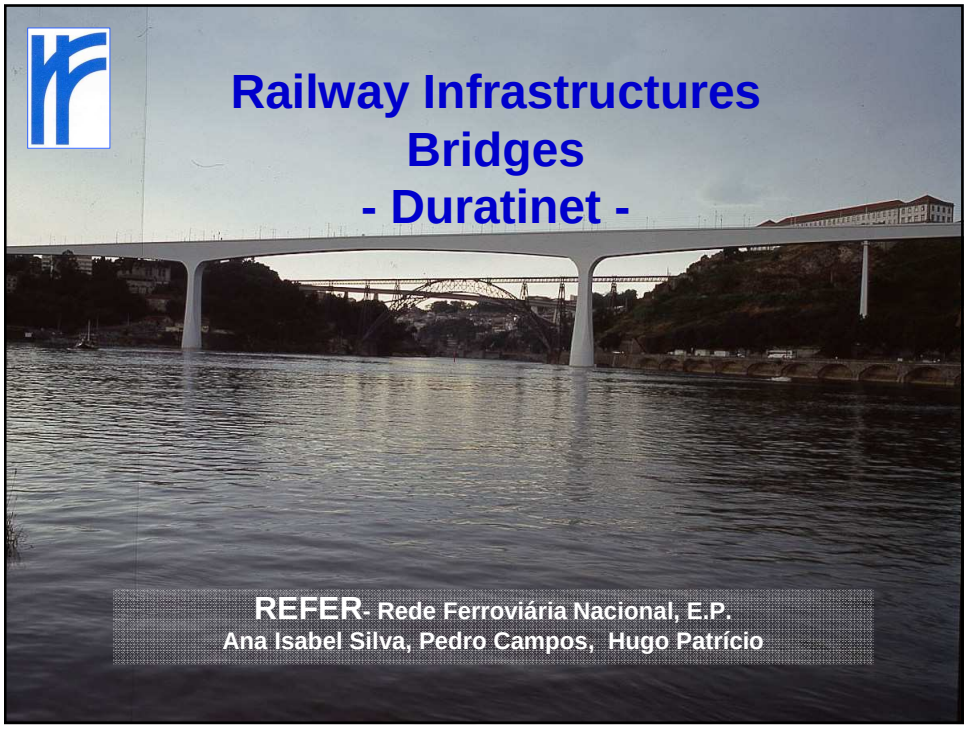
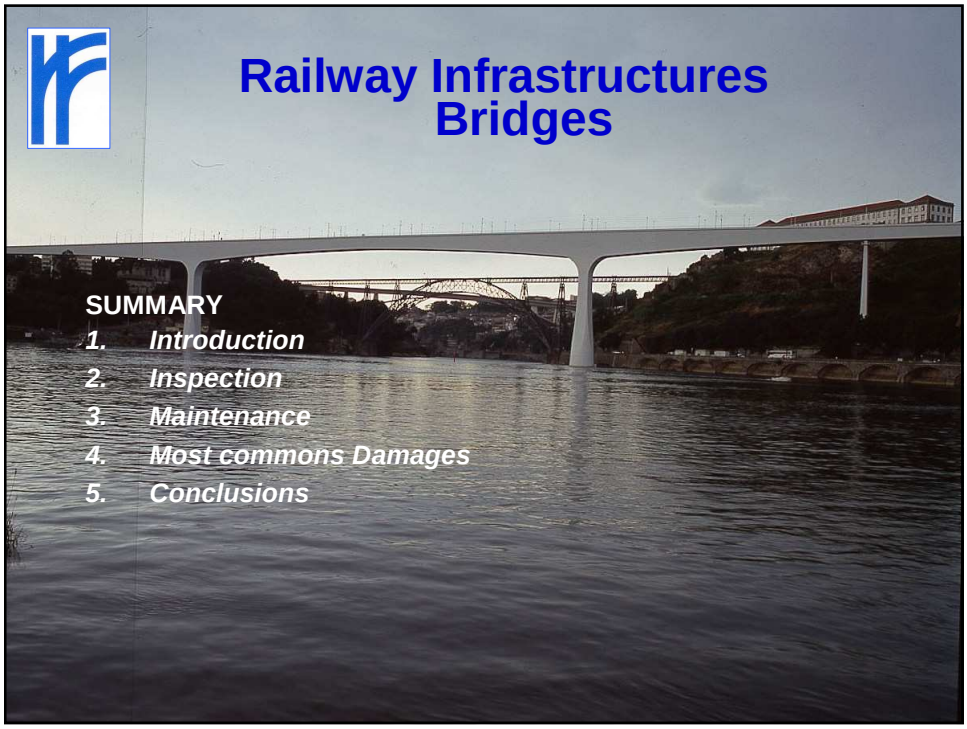

Railway Infrastructures
Bridges
- Duratinet -
REFER- Rede Ferroviária Nacional, E.P.
Ana Isabel Silva, Pedro Campos, Hugo Patrício


Railway Infrastructures
Bridges
SUMMARY
1. Introduction
2. Inspection
3. Maintenance
4. Most commons Damages
5. Conclusions

1. REFER - Vision & Mission

PURPOSE

-**manage** the national railway network, comprising construction, conservation and maintenance of infrastructure, preservation of property assets and traffic capacity management.

OBJECTIVES

- Provide a **reliable** railway network, its levels of quality being assessed by standards recognized and accepted by all, in particular Railway customers;

- Ensure the **availability** of the network and the **integrity** of its assets;

MISSION

- Supply the market with a competitive transport infrastructure by managing and developing a safe, efficient, environment-friendly rail network, contributing to the greater use of the Railway.

1. Railway Infrastructure

Bridges in use

- 2500 Bridges excluding hydraulic passes (span<2.0m)
- Total length aprox. 47,000 km

Metallic Bridges (Steel, wrought iron)

Age (years)	< 10	10-30	30-60	60-100	>100
Number	19	155	141	268	119
Length	600m	3650m	2316m	6715m	8737m

Concrete Bridges

- 850 concrete bridges (prestressed included)
- For the last 10years more than 300 bridges have been erected.

Masonry Bridges

- 850 masonry bridges.

1. *Introduction*
2. Inspection
3. Maintenance
4. Most commons damages
5. Conclusions

DURATINET
LNEC, 19-20/Feb

1. Bridge Management System

The objectives defined for this organization are basically the following:

- To assure the safety of the structures, maintaining them at the level of capacity predicted in design;
- To assure that the railway traffic is done without restrictions and under the conditions of comfort and velocity predicted;
- To maintain the register of bridges updated, organising the information management in order to plan and optimise the interventions, minimising costs and interferences with the circulation.
- Design rehabilitation and replacement projects

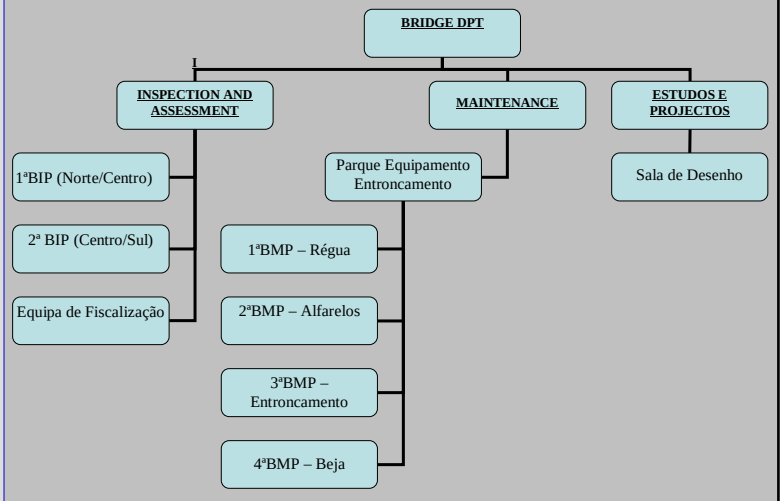
To fulfil those objectives the Bridge Department is divided into three main fields:

- Inspection and Diagnosis;
- Rehabilitation and Maintenance;
- Studies and projects

1. *Introduction*
2. Inspection
3. Maintenance
4. Most commons damages
5. Conclusions

DURATINET
LNEC, 19-20/Feb

1. Introduction



Bridge Dpt. - Organigram

1. Introduction
2. ***Inspection***
3. Maintenance
4. Most commons damages
5. Conclusions

DURATINET
LNEC, 19-20/Feb

2. Inspection

In general, it can be said that the main objectives of the inspection of bridges are the knowledge of their real condition, the detection of existing damages and finding out the causes of the identified damages. That real condition must be compared with a reference condition. The frequency of evaluation depends on the real condition.

Thus, for what respects to the type of bridge inspections, the present approach in the REFER is as follows:

- Routine (1 year)
- Main (3/4 years)
- Special (when needed)

All this information is presented in this report, with photos of the damages detected, classified according to their severity. A classification index of the global structure is obtained after weighting and combining all the damages identified.

1. Introduction
2. ***Inspection***
3. Maintenance
4. Most commons damages
5. Conclusions

DURATINET
LNEC, 19-20/Feb

2. Inspection – Visual Inspection

1. Introduction
2. ***Inspection***
3. Maintenance
4. Most commons damages
5. Conclusions

DURATINET
LNEC, 19-20/Feb

2. Inspection – Batimetrics / Geometric Leveling

Batimetrics

Precise Geometric Leveling

1. Introduction
2. ***Inspection***
3. Maintenance
4. Most commons damages
5. Conclusions

DURATINET
LNEC, 19-20/Feb

2. Inspection – Underwater Inspection

1. Introduction
2. ***Inspection***
3. Maintenance
4. Most commons damages
5. Conclusions

DURATINET
LNEC, 19-20/Feb

2. Inspection – Measurement / Sampling

1. Introduction
2. ***Inspection***
3. Maintenance
4. Most commons damages
5. Conclusions

DURATINET
LNEC, 19-20/Feb

2. Inspection – Measurement/ Sampling


Rebar Detection


Core Drilling


Crack Measurement

3. Maintenance

1. Introduction
2. Inspection
3. ***Maintenance***
4. Most commons damages
5. Conclusions

Preventive maintenance of bridges has as a basic objective of assuring the normal behaviour of the structure and its equipments. It includes minor damage reparation with the purpose of delaying the evolution for more severe situations.

To accomplish this, REFER has four national maintenance brigades which, apart from the current maintenance works, carry out the annual routine inspection of all the bridges in the network.

3. Maintenance

1. Introduction
2. Inspection
3. ***Maintenance***
4. Most commons damages
5. Conclusions

- **General cleaning of structures:**




3. Maintenance

- **More Cleaning…**

1. Introduction
2. Inspection
3. ***Maintenance***
4. Most commons damages
5. Conclusions

3. Maintenance

- **Bearings' Cleaning and Lubrication:**

1. Introduction
2. Inspection
3. ***Maintenance***
4. Most commons damages
5. Conclusions

1. Introduction
2. Inspection
3. *Maintenance*
4. Most commons damages
5. Conclusions

DURATINET
LNEC, 19-20/Feb

3. Maintenance

- **Coating Repair**




1. Introduction
2. Inspection
3. *Maintenance*
4. Most commons damages
5. Conclusions

DURATINET
LNEC, 19-20/Feb

3. Maintenance

- **Concrete Repair:**




3. Maintenance

- **Replacement of Structural Elements:**

1. Introduction
2. Inspection
3. ***Maintenance***
4. Most commons damages
5. Conclusions

3. Maintenance

There are also some preventive maintenance works that, due to their specificity, are carried out by specialized contractors,

This is the case of the anticorrosive protections of steel bridges, including blasting.

1. Introduction
2. Inspection
3. ***Maintenance***
4. Most commons damages
5. Conclusions

1. Introduction
2. Inspection
3. Maintenance
4. ***Most commons damages***
5. Conclusions

DURATINET
LNEC, 19-20/Feb

4. Common Damages

Corrosion in steel bridges



1. Introduction
2. Inspection
3. Maintenance
4. ***Most commons damages***
5. Conclusions

DURATINET
LNEC, 19-20/Feb

4. Damages

Corrosion of reinforcing steel




1. Introduction
2. Inspection
3. Maintenance
4. Most commons damages
5. ***Conclusions***

DURATINET
LNEC, 19-20/Feb

5. Conclusions

From our experience, the fundamental parameters to ensure an appropriate bridge behaviour with unequivocal reflexes in the durability are:

- **Permanent preventive maintenance** in the structure and equipments associated, making them work as predicted in the design, diminishing or annulling the resultant damages of non conformities in service;
- Be aware of ageing and natural degradation of the materials, rehabilitating the structures for higher velocities and loads when necessary, paying special attention to the fatigue phenomena, particularly important in steel structures.

1. Introduction
2. Inspection
3. Maintenance
4. Most commons damages
5. ***Conclusions***

DURATINET
LNEC, 19-20/Feb

5. Conclusions

It must be stated out that the guarantee of an appropriate durability and structural behaviour cannot be only based in the maintenance actions done in service. It should always start at the design and/or construction phase, with the inclusion of procedures necessary to make the actions of inspection and maintenance easier:

- Good accessibility for inspection of the entire bridge, including supports, even with the help of complementary and permanent equipments as platforms, etc.;
- Permanent instrumentation placed in the construction phase: extensometers, load cells for measuring of support reactions, etc.;
- A detailed and documented final report, containing all the relevant information about the construction: tests performed, initial survey before the bridge is put into service, etc., in order to make it possible for the future maintenance manager to gather information about possible causes of later damages.

Finally, it is worth to say that however adequate and developed the maintenance strategy is defined, it will always have as objective to maximise the safety levels and minimise failure risks, even though it is not possible to eliminate them completely.

REFER- Rede Ferroviária Nacional, E.P.
Ana Isabel Silva, Pedro Campos, Hugo Patrício