# Evaluation of Bridge Condition for Improved Maintenance Policy
Évaluation de l'état des ponts pour une meilleure politique de gestion
Beurteilung der Brückenzustände für eine bessere Unterhaltspolitik

**Yves ROBICHON**
Chief Engineer
Direction des routes
Paris, France

**Christian BINET**
Chief Engineer
SETRA
Bagneux, France

**Bruno GODART**
Civil Engineer
LCPC
Paris, France

## SUMMARY

This article describes the quoting system and the method used by the French Ministry of Transportation for evaluating the condition of the bridges situated on the French national road network. The objective is to give an "IQOA" indicator representative of the overall state of the network. The first evaluation of all bridges longer than 2 meters was made in 1994. The paper presents the main results.

## RÉSUMÉ

Cet article décrit le système de cotation et la méthode utilisée par le ministère de l'Équipement, des Transports et du Tourisme pour évaluer l'état des ponts situés sur le réseau routier national non concédé français; l'objectif est de fournir un indicateur "IQOA" représentatif de l'état global du patrimoine; la première évaluation a été faite en 1994 sur la totalité des ponts de plus de 2 mètres de portée; les principaux résultats sont fournis.

## ZUSAMMENFASSUNG

Dieser Artikel beschreibt das Notiersystem und die vom Infrastruktur- und Verkehrsministerium verwendete Methode, um die heutige Lage der Brücken auf dem französischen nicht konzessionierten Straßennetz zu bewerten; das Ziel ist es, einen Indikator "IQOA" zu geben, der für die Gesamtlage des Brückenbestands repräsentativ ist; die erste Bewertung von allen mehr als 2 Meter langen Brücken fand 1994 statt; die hauptsächlichen Ergebnisse werden vorgestellt.

## 1. THE FRENCH ROAD NETWORK. MAINTENANCE POLICY IN THE NATIONAL NETWORK.

The French road network has about 900,000 km of roads, of which 36,000 km belong to the State; 6,000 km are operated by toll motorway companies, and 30,000 km are managed directly by the Road Directorate of the Ministry of Equipment, Transportation and Tourism.

On the national non-conceded road network managed directly by the Road Directorate, we could register a patrimony of 18,500 more than 2 m long bridges, 1,000 km of retaining walls, 45 km of tunnels and 96 km of noise barriers. The only bridges represent a value estimated at 70 milliards of French francs, or about 10 % of the value of the whole corresponding road patrimony.

Since 1992, the Road Directorate is engaged in a voluntary policy of preserving the condition of its patrimony, whether it may be composed of pavements or of bridges, and to this end they put two indicators into place, namely:

- IQRN (Image Qualité du Réseau National) for pavements,
- IQOA (Image Qualité des Ouvrages d'Art) for bridges.

This last indicator is now extended to tunnels and will later on be so for retaining walls.

The objective of this is:

- to have an evaluation of the condition of the network and its evolution in time by means of physical and financial indicators,
- to draw economic lessons from this evaluation in order to fix the yearly budgets for maintenance,
- to define the policies for the contract maintenance by managing services.

At present, the Road Directorate devotes about 300 million French francs every year as external costs for the maintenance and repairing of its patrimony in bridges, or about 0,45 % of its value.

## 2. ORGANIZATION OF THE SUPERVISION AND MAINTENANCE OF THE BRIDGES IN THE NATIONAL NETWORK

The construction and management of the national road network are placed under the authority of the Road Directorate giving a great decision delegation to the County Directorate (DDE), which are one hundred in number, in the framework of the budgetary credits allocated to them.

The continuous supervision of the bridges is under the responsibility of Land Sub-Divisions, which are a dozen per DDE on average ; the supervision is made according to an instruction of 1979 fixing the periodicity and level of inspections as a function of the importance of the structure and the risks it generates.

These Sub-Divisions have at their disposal technical support made up of a Departmental Cell for Engineering Structures (CDOA) placed in the office of the County Directorate and in charge of evaluating the severity of defects, giving a diagnosis, making repair projects and proposing intervention priorities to the County Director.

For detailed inspections requiring specialized means of access or measurement, or for making analyses or studies on complex bridges, the County Direction can call upon specialized centres (Centres d'études techniques de l'Equipment), 8 in number in France, but in any case the County Directorate remains responsible for the quality of the supervision and the good state of the bridges.

The specific methods and materials necessary for their tasks are prepared and distributed by the Service d'Etudes Techniques des Routes et Autoroutes (SETRA) and the Laboratoire Central des Ponts et Chaussées (LCPC).

## 3. INVENTORY

The diagram Figure 1 illustrate the composition of the patrimony of bridges and culverts of a length superior to 2 meters analysed by type of bridge.
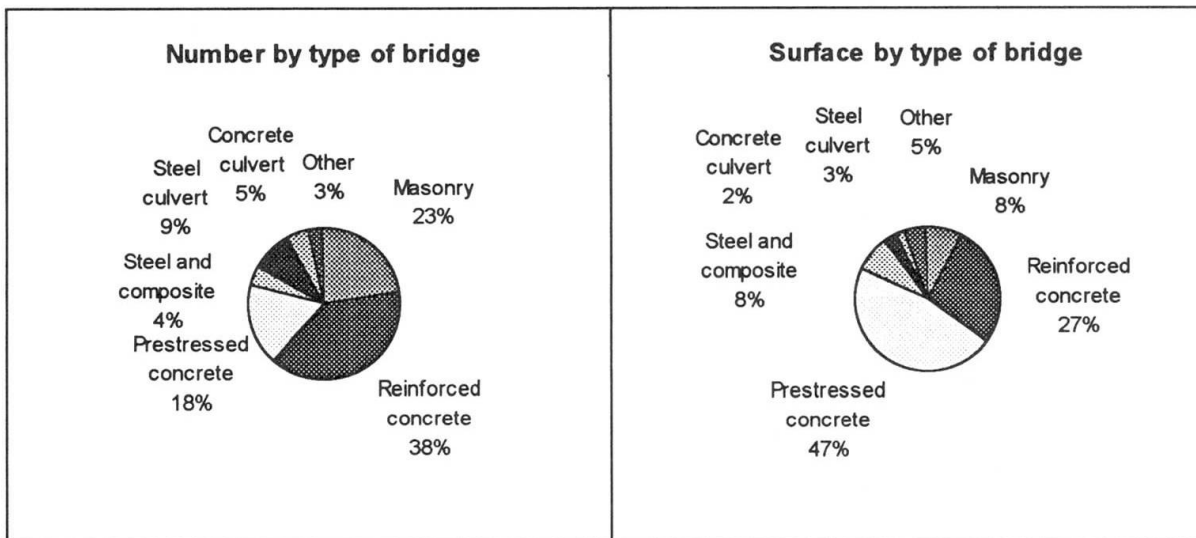


*Figure 1 : Inventory of bridges and culverts greater than 2 meters*

## 4. EVALUATION OF THE PATRIMONY CONDITION

The evaluation made in the framework of the IQOA operation dealt with the whole patrimony of bridges and culverts, or 18,500 structures ; it was made using the detailed inspection reports when these existed and were sufficiently recent ; for the rest of the patrimony, the evaluation was made on the basis of a rapid visual appraisal made during a period of half a day per bridge and without specific means of access.

This evaluation was made in such a way that we could distinguish the condition of equipment (pavements, footways, cornices, retaining devices, drainage devices, expansion joints under pavements and footways, operating equipment, etc.), the condition of the protection elements (waterproofing layers, the anticorrosion coating of metal surfaces, stone facing, rocks, etc.), as well as the condition of structure elements (bridge decks, supports, bearing devices, foundations). This distinction allowed us to define three great classes of characterizing the state of the bridges:

- class 1 groups the bridges in apparently good condition ;
- class 2 concerns the bridges showing defects of equipment or protection elements, or minor structural defects ;
- class 3 unites bridges with damaged structures.

A sub-classification was made to take the urgency of intervention into account. So in the bridges of class 2, we distinguish the bridges of class 2E requiring urgent special maintenance in order to prevent the development of disorder in the structure (for instance of a faulty waterproofing layer), and the bridges of class 2S requiring an urgent intervention in order to

warrant the security of the road users (for instance a damaged balustrade). Among the bridges of class 3, we distinguish those in class 3U requiring urgent repair works because of an immediate or short-time insufficience of bearing capacity. The decision flow chart presented resumes this method of classification.(Figure 2)
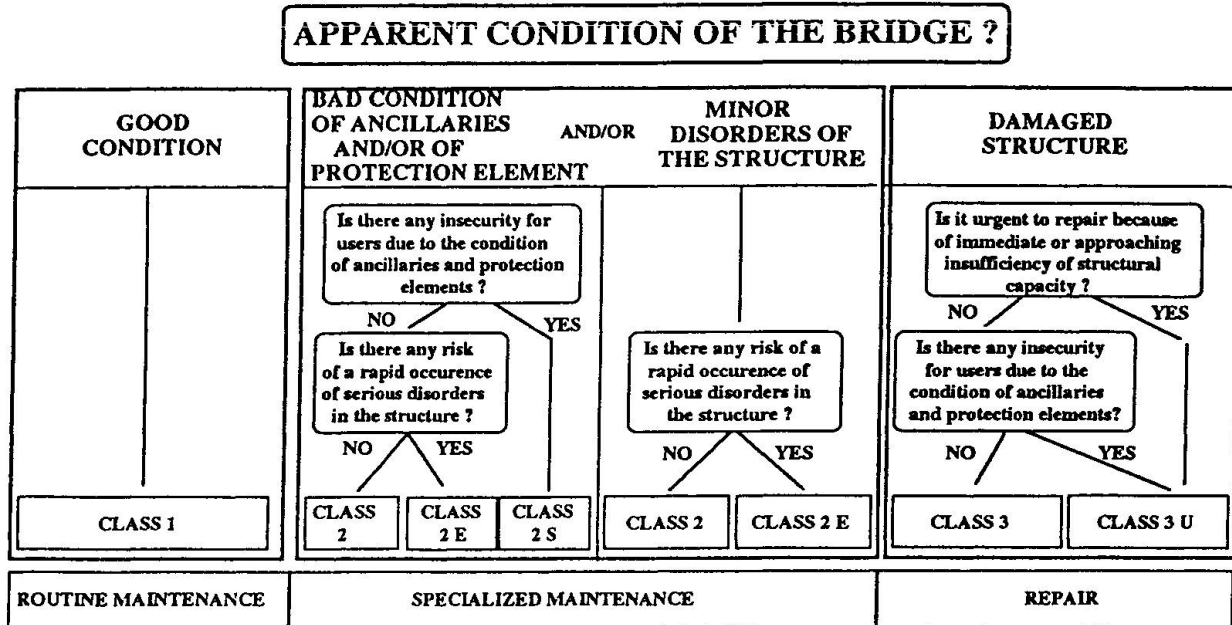
| APPARENT CONDITION OF THE BRIDGE ? | | | |
|---|---|---|---|
| **GOOD CONDITION** | **BAD CONDITION OF ANCILLARIES AND/OR OF PROTECTION ELEMENT** AND/OR **MINOR DISORDERS OF THE STRUCTURE** | | **DAMAGED STRUCTURE** |
| | Is there any insecurity for users due to the condition of ancillaries and protection elements ? | | Is it urgent to repair because of immediate or approaching insufficiency of structural capacity ? |
| | NO / \ YES | | NO / \ YES |
| | Is there any risk of a rapid occurence of serious disorders in the structure ? | Is there any risk of a rapid occurence of serious disorders in the structure ? | Is there any insecurity for users due to the condition of ancillaries and protection elements? |
| | NO / \ YES | NO / \ YES | NO / \ YES |
| CLASS 1 | CLASS 2 / CLASS 2 E / CLASS 2 S | CLASS 2 / CLASS 2 E | CLASS 3 / CLASS 3 U |
| **ROUTINE MAINTENANCE** | **SPECIALIZED MAINTENANCE** | | **REPAIR** |

_Figure 2_ : _Flow chart for classification of bridges_

In order to make use of the operation of evaluating the condition of the bridges in situ, all the bridges were divided into two categories:

- the first category concerning the common bridges which have been inspected by the Equipment Sub-Divisions, which have thus made up the exhaustive list of defects found on each bridge ; this first rating was then validated by the CDOA centre.
- the second category groups the rest of the bridges whose rating was made directly by the CDOA, by means of the results of a recent detailed inspection, or on the basis of a rapid visual appraisal.

In order to help all the actors in the classification and ensure the homogeneity of the rating on the whole territory, the Réseau Technique de l'Equipement, made up of the SETRA, the LCPC and the CETE's elaborated the two following types of documents:

- **the inspection reports** intended to the agents of the Sub-Divisions and made in such a way that people without a specialized knowledge of bridges should be able to class the different defects stated ; these documents are richly illustrated (see Figure 3) and include the complete illustrated list of all the defects that it is possible to find in a given type of bridge

- **catalogues of the main disorders** explaining the defects and their possible causes and proposing a class for each type of defect ; these 23 documents form an aid to the classification for the CDOA's use.

The documents were distributed when launching the IQOA campaign, with the putting into place of a specific training, intended on the one hand to the CDOA directors and on the other hand to the agents of the Sub-Divisions in charge of inspecting the bridges.

The class assigned to a piece of equipment, an element of protection or a part of the inspected bridge is obtained by choosing the highest of the quotations mentioned for each defect connected with it. On the basis of a summary sheet resuming for each structure the class assigned to the equipment, the deck and the supports, the CDOA assigns the bridge to the most unfavourable class.

All the information contained in the summary sheets, namely the main characteristics of the structure and the results of the evaluation, are then united into a data file ; after the control of the homogeneity of the ratings by the CETE's, the processing of this file is then achieved at the national level.

An evaluation of the rating accuracy and more particularly the correctness of placing bridges into classes 3 and 3U will be done during this year, if necessary after more detailed inspections.
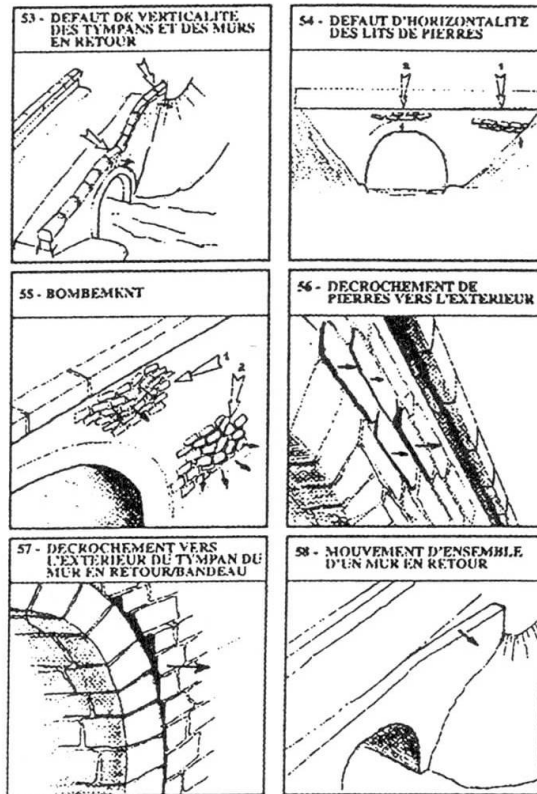


*Figure 3* :*Example of visit report of disorders (for masonry bridge)*

## 5. THE MAIN RESULTS OF THE EVALUATION

The following graph charts give the main results of the first campain of evaluation : the distribution by class (in number and in surface) and the analysis according to the type of bridge.
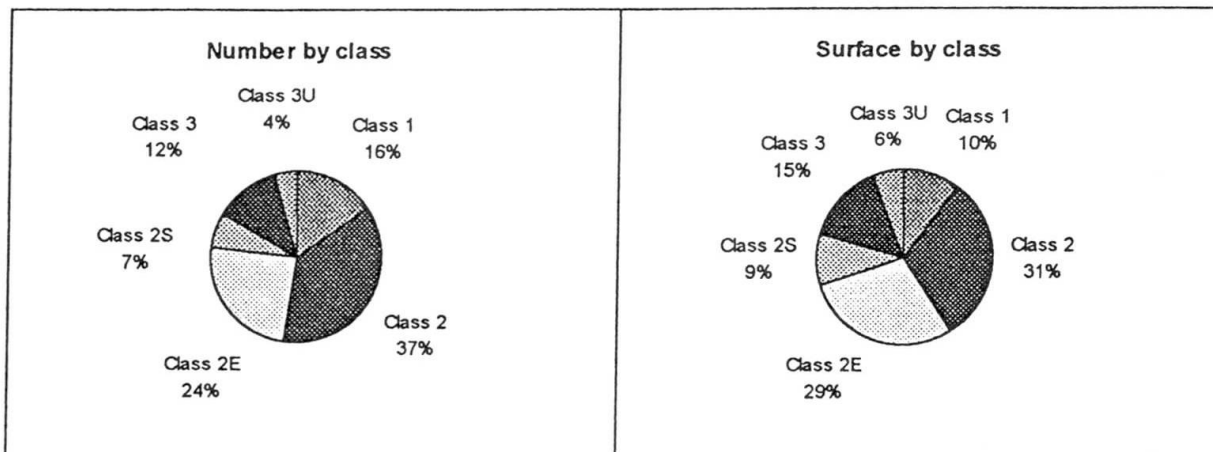


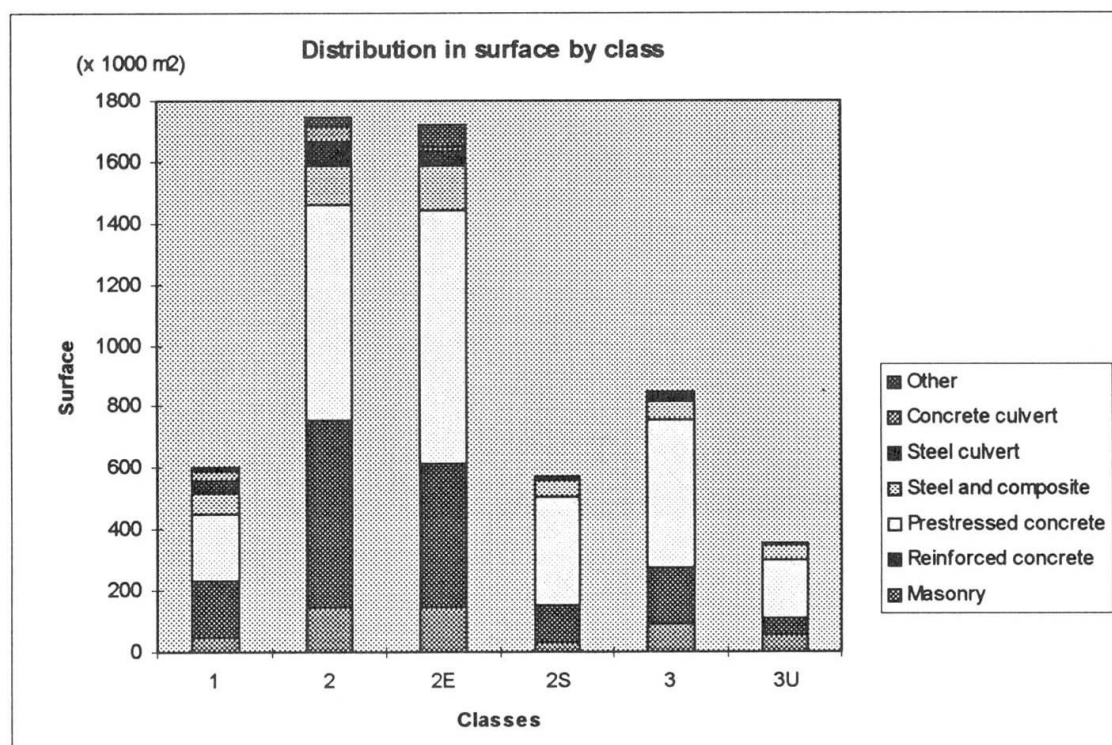*Figure 4 : Overall distribution by class of bridges and culverts*

_Figure 5_ : _Distribution by class according to the type of bridge_

## 6. ESTIMATION OF THE REPAIR COSTS

The following step foreseen in 1995 consists of estimating the costs for repairing the patrimony independently of any budgetary constraint ; the method is based on the principle of segmentation of the population as a function of the criteria having a strong influence on the costs (criteria such as class, age, type of bridge, ...) ; after the lot-drawing of a sample of bridges, we are going to make a precise estimation of the repair costs of the chosen bridges and extrapolate them to the whole population. Other information such as the estimation of the costs of the bridges stated in the three-year plan of heavy repairs, will be used in the framework of this operation.

## 7. CONCLUSION

The evaluation of the bridges in the national road network was launched in April 1994. At the end of the year 1994, about 80 % of the bridges have been inspected and classified ; we must note that the DDE agents were rapidly engaged in this operation, which has the first merit of giving them a package of tools for inspecting the bridges, which was missing before ; the return of information on the patrimony of each DDE will allow us to improve the taking into account of its preservation in the ongoing maintenance programming.

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