Condition Rating and Maintenance System for Railway Bridges in Poland

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Changes in the national economies in Central Europe stimulate changes in bridge maintenance systems. The SMOK railway bridge management system was designed and developed at Wroclaw Technical University for Polish State Railways. The main idea of the new system is to combine the new maintenance unit organization with a new inspection system and to implement a computer system to support the collection and processing of data for bridges. The huge amount of fresh and modern knowledge and technology will fill all elements of the management system; among these also will be expert computer systems and economical optimization for supporting the decision-making process.

Polish State Railways (PKP) is a state company, the general director of which reports directly to the Minister of Transport and Maritime Economy. PKP is the third largest railway in Europe, after those of Germany and France, and has more than 23 000 km of lines and almost 48 000 km of tracks.

The total number of civil structures is almost 35,000, among which there are almost 10,000 bridges with spans of more than 3 m (Figures 1 and 2). The 64 percent civil structures that are part of Poland's railways were built before the beginning of the World War I in 1914, and only 20 percent of bridges are younger than 50 years (Figure 3). It shows how big a bridge maintenance problem PKP management has.

After changes in the Polish economy in 1990, the Permanent Way Head Management, which is part of the general management of PKP, noticed that the traditional way of bridge maintenance failed and started working to prepare a new system. In 1993, in cooperation with the Technical University in Wroclaw, PKP stated new technical, organizational, formal, and economic rules of railway civil structure management. Implementation of the system (Figure 4) was started in 1994 by developing the training system and a computer-supported information system and by setting up new organizational units: bridge divisions (Figure 5).

Inspection System

The heart of the maintenance system is new rules of inspection executed by a staff of 200 inspectors who are selected and specially educated for this purpose. There are five types of railway civil structure inspections (Tables 1 to 3):

1. General overview: executed by the track inspector during everyday track inspection; no equipment or procedure is used; the inspector makes notes in an inspection book if any imperfections are found.

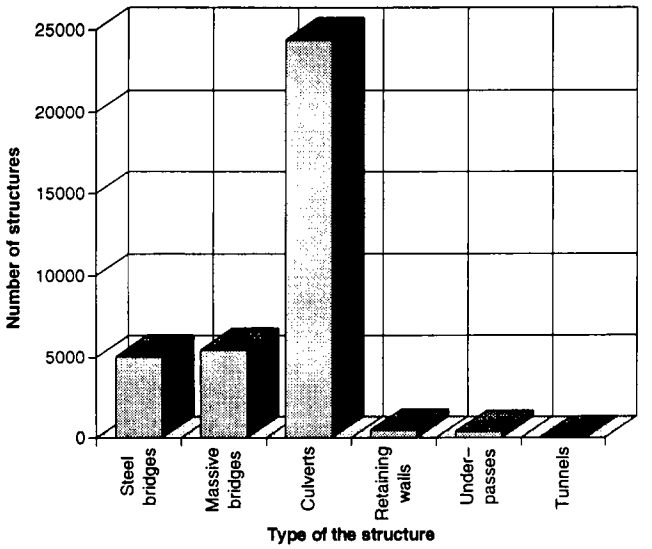

FIGURE 1 Total number of civil structures owned by Polish Railways.

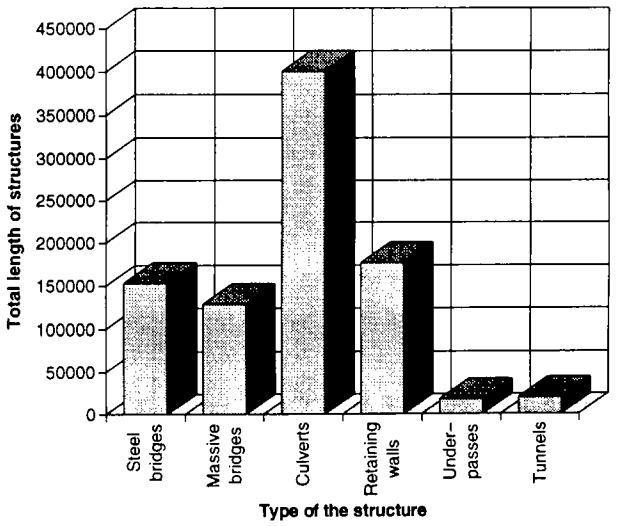

FIGURE 2 Total length of civil structures owned by Polish Railways.

2. Current inspection: executed by the bridge inspector or bridgemaster at least once every 3 months with the use of binoculars; comparison of the condition described in the report of the last basic or more professional inspection is done, and the bridge inspector makes notes in an inspection book if any imperfections are found.

3. Basic inspection: executed by the bridge inspector with the help of the bridgemaster at least once every 1 or 2 years, depending on the condition of the structure, using a set of tools for measuring and simple testing, making photographs, and filling in a special report form, gathering data on bridge condition, serviceability, main deficiencies, and maintenance and repair work needs (Figures 6 to 8).

4. Detailed inspection: executed by the division inspector accompanied by the bridge inspector and the bridgemaster; it is executed at least once every 5 years, depending on the bridge's structural condition, using a wide range of equipment, which allows all necessary measurements to be made and some not very difficult tests to be performed; it always verifies the information in the report from the basic inspection and solutions to problems pointed out by the bridge inspector but that are too complicated to be solved by the bridge inspector; it describes precisely the scope and rough costs of general repairs.

5. Special inspection: executed by consultants, scientists, and testing companies accompanied by division and bridge inspectors, and is ordered by the division inspector in case of problems that need high professional expertise; the result is an opinion that should identify the problem and the requirements for further use of the bridge or a description of the work that must be done.

Basic Inspection and Maintenance Planning

The most important inspection from the point of view of bridge management is the basic inspection, which gives 95 percent of the information about structures and is therefore the base for maintenance work plan-

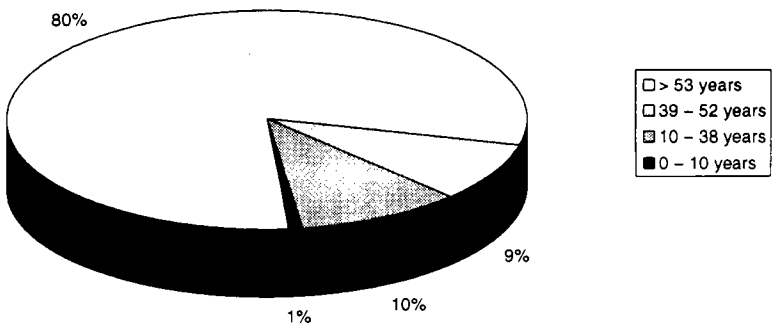

FIGURE 3 Ages of PKP civil structures.

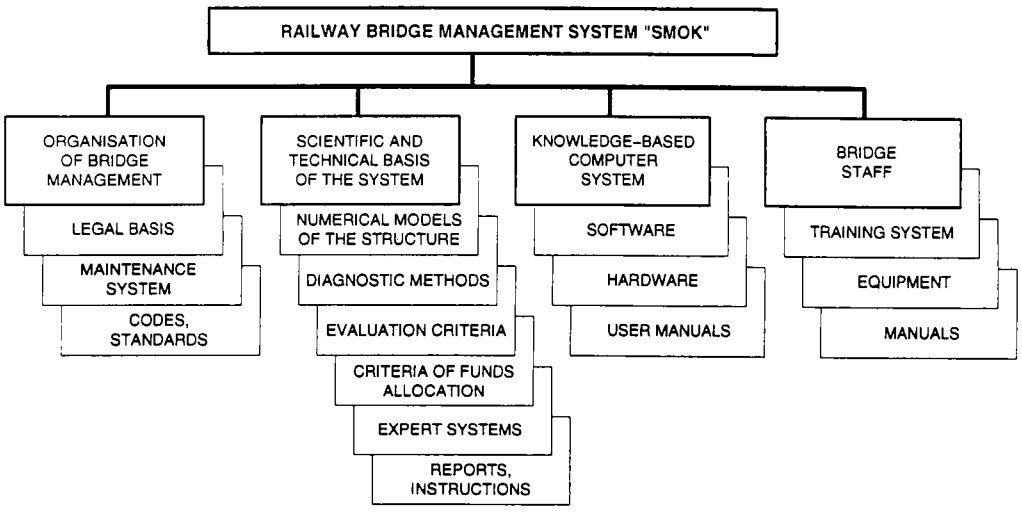

FIGURE 4 Main components of the SMOK railway bridge management system.

ning and selecting structures for repairs. Basic inspection allows observation every year of changes in construction condition and serviceability, selects bridges for conservation and preventive work, and indicates the structures that need inspections by more experienced inspectors.

Such a system saves the time of division inspectors with higher levels of education and more experience and directs them to structures with really serious problems. It also provides a chance for the true owners of bridges to take full responsibility for them.

SMOK Computer System

Execution of each inspection is supported by a computer system for collecting the data derived during inspections, both inventory and a description of the conditions of structures. There also is a place for notes about the need for maintenance work and use restrictions.

During or after basic inspections data from the report form are put into the information system. Condition notes and work cost estimations will be the basis

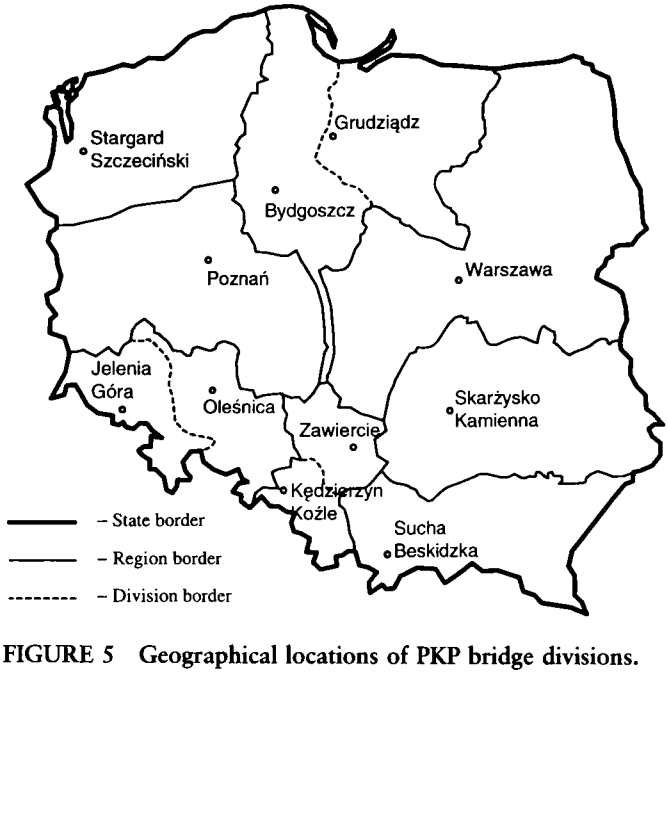

FIGURE 5 Geographical locations of PKP bridge divisions.

TABLE 1 Structural Elements for Condition Rating

TYPE OF THE STRUCTURE	
BRIDGES, VIADUCTS, PEDESTRIAN OVERPASSES	
0 :	whole structure
1 :	abutments
2 :	piers
3 :	main girders
4 :	deck
5 :	bearings
6 :	water proofing
7 :	drainage
8 :	accessories
9 :	non-bridge installations
10 :	approaches/stairs
11 :	underpass
TUNNELS, UNDERTRACK PASSES	
0 :	whole structure
1 :	construction
2 :	entrance walls/stairs
3 :	water proofing and drainage
4 :	accessories
CULVERTS	
0 :	whole structure
1 :	construction
2 :	entrance walls and slopes
3 :	underpass
RETAINING WALLS	
0 :	whole structure
1 :	construction
2 :	slopes

TABLE 2 Scale of Condition Rating

5	no problems, no repair is needed in next 10 years, in the following year only conservation works
4	small dysfunctions which do not need repair in following 3 years; in the following year only conservation works
3	defects which must be repaired in following 2 years; in the following year possible conservation works
2	reasonable defects which are not dangerous for bridge safety, but need repair in the following year
1	serious damage which may be dangerous for bridge safety and needs major repairs in the following year
0	very serious (dangerous) damage which is very dangerous for bridge safety and needs emergency repair

TABLE 3 Scale of Serviceability Rating

5	operation without restrictions - full serviceability
4	operation without restrictions - small dysfunctions like restricted clearance under the bridge, noise, ugly appearance
3	operation with restrictions of the clearance on the bridge (or in the tunnel)
2	operation with the lowered speed of the trains on the structure (or in the tunnel)
1	operation with reduced loads on the structure
0	structure out of use

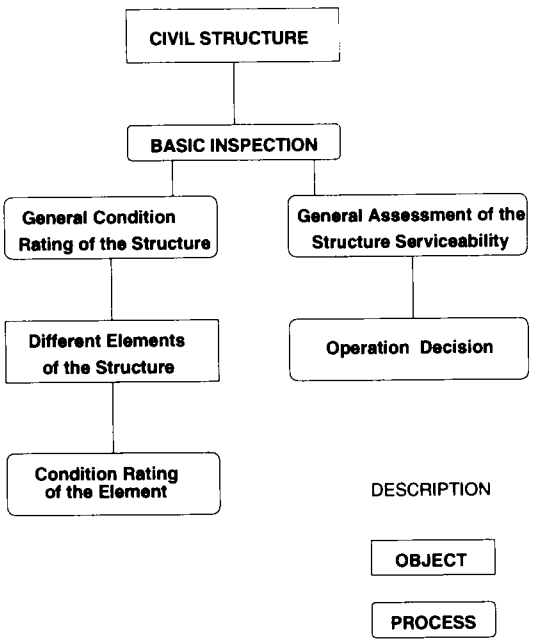

FIGURE 6 Evaluation of bridge structures during basic inspection.

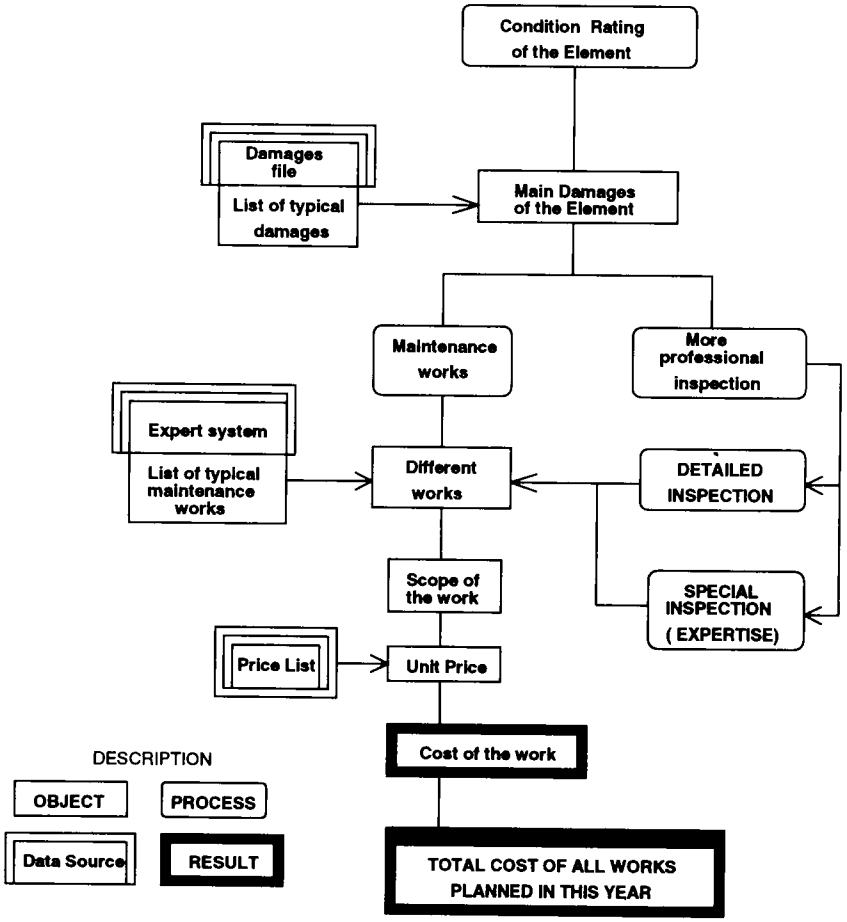

FIGURE 7 Basic inspection: results of condition rating.

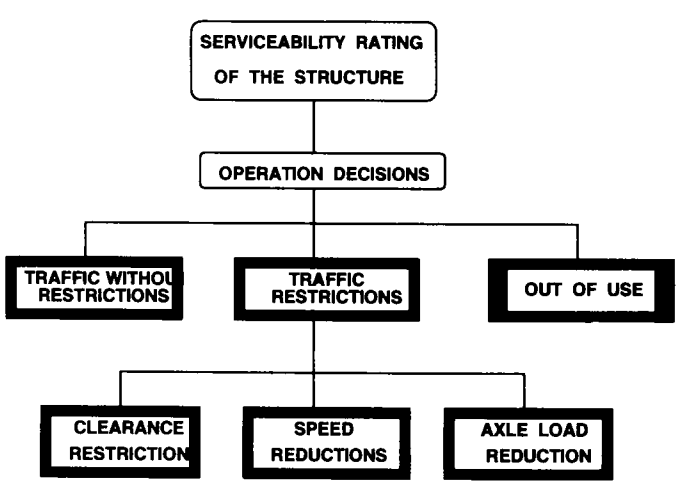

FIGURE 8 Basic inspection: results of serviceability rating.

for preparing priority ranking lists and for determining long-term financial needs.

Detailed inspections verify the data from the basic inspections and add the results of all tests and measurements made during those inspections. Very important is information about the needs for repairs and other maintenance work combined with cost estimates. These data will be created as three different strategies for every structure treated. The information created during the detailed inspection will be the formal base for making financial plans for the following year. These data will be also used to optimize funds allocations among bridges technically selected for repairs.

The computer system supporting bridge maintenance will allow the following:

- Collection of different kinds of data,
- Transfer of data to higher management levels,
- Translation of numerical condition assessments to economic parameters of procedures that support decision making, and
- Application of some expert procedures useful for bridge managers at all levels of the PKP organization.

The computer system consists of bridge inspector terminals (far terminals), division terminals operated by division inspectors, computers in the offices of regional bridge managers, and the computer in the Civil Structures Department of General Management.

In the first organizational step, computers will work as isolated terminals; information will be transferred only by diskettes or telephone modems. After implementation of the Polish Railway Computer Net KOLPAK in 1995 and getting access to it, the computers of the SMOK system (but not the far terminals) will become terminals of KOLPAK. The bridge data bases will be located in bridge divisions, and inspector terminals will become subterminals of KOLPAK by connection only with division terminals. All of the computer software for bridge management was originally prepared for PKP by the Technical University in Wrocław.

Conclusions

Permanent Way Head Management assumes that 15 to 20 percent of today's spending for railway bridge maintenance is not used properly because of inadequate directing of finances and improper work execution. This is mainly caused by the lack of reliable information about the numbers of and conditions of the bridges and by financial needs estimates, which are not always made by professionals.

Preparing educated staff and setting modern inspection procedures, supporting data collection and transfer of data by a computer system, preparing priority rankings, and using economical procedures for decision-making assistance should allow PKP to spend money in a more efficient way. PKP expects that former losses in bridge maintenance expenditures should be reduced to 5 percent.

The total cost of preparing and implementing the new bridge management system will be covered by better allocation of spending and use of funds during 1 year of repair and maintenance work.