Zeitschrift: IABSE congress report = Rapport du congrès AIPC = IVBH Kongressbericht

Band: 13 (1988)

Artikel: Micro-computer based system for management of bridges

Autor: Sørensen, Anders B. / Davidsen, Lone

DOI: https://doi.org/10.5169/seals-12998

Micro-Computer Based System for Management of Bridges

Système de surveillance et entretien des ponts à l'aide de micro-ordinateurs

Ein Micro Computer System für die Verwaltung von Brücken

Anders B. SØRENSEN
Consulting Engineer
Cowiconsult
Copenhagen, Denmark

Anders B. Sørensen, born 1949, received his Master's Degree in Civil engineering at the Technical University of Denmark in 1974. He has worked with Cowiconsult since 1974 and has been in charge of many larger bridge design works. He has been responsible for the development of the Bridge Management and Maintenance System.

Lone DAVIDSEN
Civil Engineer, BSc.
Cowiconsult
Copenhagen, Denmark

Lone Davidsen, born 1958, received her Bachelor's Degree in Civil engineering at the Technical University of Denmark in 1984. She has worked with Cowiconsult since 1986 and has been responsible for the database design and programming of the Bridge Management and Maintenance System.

SUMMARY
The Bridge Management and Maintenance System is implemented for PC-computers as a menu driven, user friendly system to be used by bridge authorities. The manuals of the system include standardized inspection routines and methods for evaluation of damages. A priority list is produced which forms the basis of maintenance detailing and final scheduling and budgeting of maintenance works.

RÉSUMÉ
Les programmes d'ordinateur pour l'entretien des ponts sont présentés sous forme d'un menu, facilement compréhensible pour l'utilisateur, la Direction des Ponts et Chaussées. Les modes d'emploi comprennent les inspections de routine et les méthodes d'évaluation des dommages. Une liste de priorités est fournie par l'ordinateur et elle est la base de la planification financière et dans le temps des opérations d'entretien.

ZUSAMMENFASSUNG
Das Programm für die Verwaltung und Unterhalt von Brücken wurde für PC-Computer aufgestellt, und zwar als ein benutzerfreundliches System, das von Brückenbehörden benutzt werden kann. Die Handbücher des Systems enthalten standardisierte Inspektionsabläufe und Methoden für die Bewertung von Schäden. Eine Prioritätsliste wird erstellt, die die Grundlage für detaillierte Unterhaltsmassnahmen und für die Planung und Finanzierung der Unterhaltsarbeiten bildet.

1. INTRODUCTION

COWIconsult has developed a Bridge Management and Maintnance System for - and in cooperation with - the Danish Railway Organization (DSB). The system is implemented on Personal Computers and can be used on single units or in a network. It is operated from menus with clear descriptions of the possible activities to be chosen, and the user is aided by prompts and helpscreens.

The system is divided into three modules:
- o Inventory
- o Inspection and Bearing Capacity
- o Ranking and Budgeting of Maintenance Works

A set of manuals explain the system activities and further define standards for inspection of bridges and evaluation of deterioration of the bridge elements.

The system can be used initially with just few data. Detailed data are registered when required, but always minimized by the hierarchical element description of the bridges.

The system has since December 1986 been used in the State Railway Organization for management and budgeting of maintenance for the 2200 bridges owned by the organization.

2. SYSTEM PLANNING

2.1 Background

During the last 25 years activities for the operation, maintenance and repair of the approx. 10,000 Danish bridges have increased in accordance with the rate of deterioration of especially the concrete bridges.

Regular inspection routines have been followed by the Danish Road Directorate and the State Railways as well as by other authorities in order to follow this deterioration and register current conditions.

A rating procedure for the determination of the load bearing capacity of existing bridges has also been instituted.

Budgeting and scheduling of the repair works for deteriorated bridges has been carried out centrally in the organizations mainly based on inspectors' recommendations.

In 1984 the time had come to strengthen the overall coordination of the inspections, rating and budgeting activities. Further, revisions were needed for the inspection routines, as major parts of the continuously collected inspection data were never used.

An objective procedure for evaluation and ranking of the bridges in need of repair was also required.

2.2 Objectives

A Bridge Management System deals with all activities related to the bridges after construction. The System must therefore comprise features to assist the administration in order to:

- Keep the bridges well functioning
- Ensure optimal lifetime of each bridge

in consideration of:

- Safety
- Current construction technology
- Economical restraints
- Aesthetics
- Political aspects

2.3 Outlines of the System

The requirements of the system and methods to be followed were discussed in a working group comprising:

- Representations of the future users:
  - inspectors and technical assistants
  - planners of maintenance works
  - budget authorities
- System planners and engineers with long-term experience in bridge design and rehabilitation works
- Specialists in database structuring and programming

In close and interactive cooperation the system was developed through pilot stages to a fully implemented system, that has been functioning to the client's full satisfaction for the past 1½ year.

The development of the system has been based upon the database system DATAFLEX, which has its own compiled programming language.

The following diagram shows the main activities in the system:

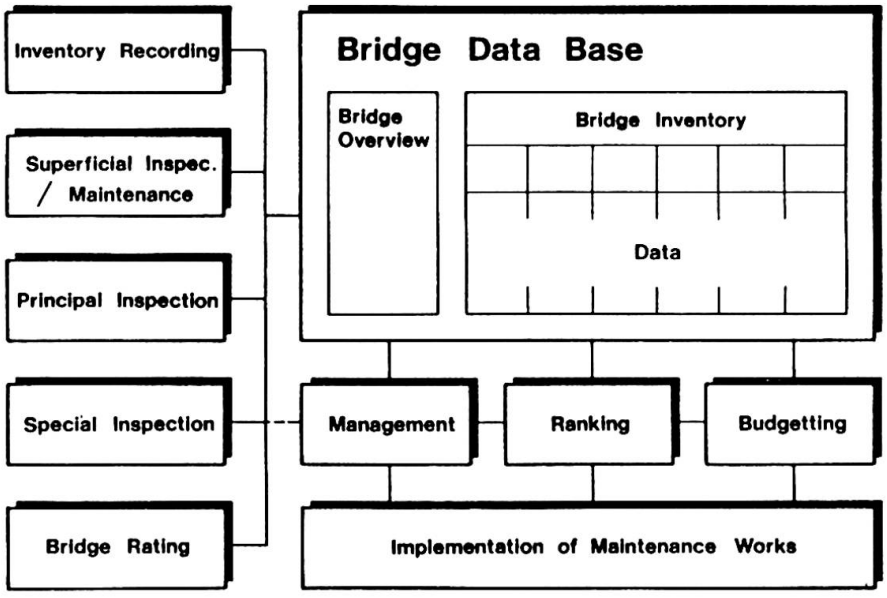

Fig. 1: Main activities covered by the system.

Administrative information and description of condition is referred to an element, which can be the bridge as a whole or a specific part (element) of the bridge. By using this method, the amount of data can be kept at a minimum corresponding to the detailing required. An extract of the total element list for a bridge is shown below.

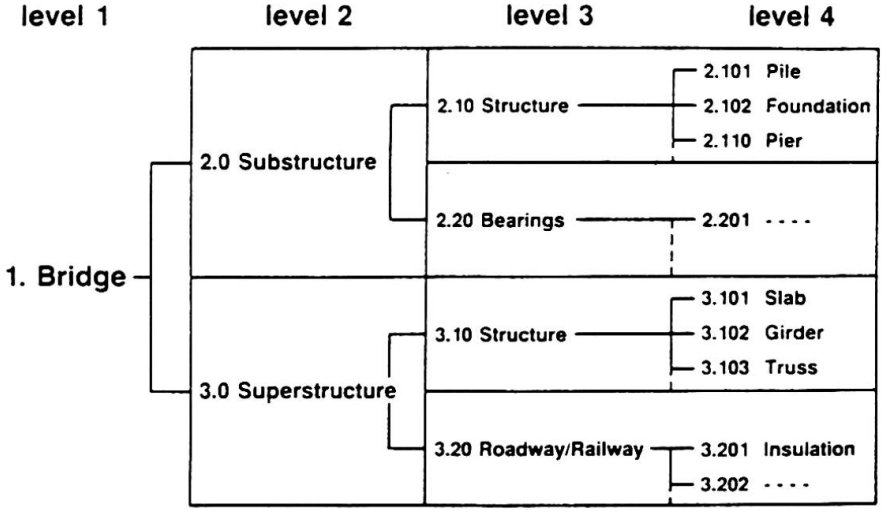

Fig. 2: Hierarchical structure of elements

Detailed data for deteriorated elements at level 4 can be abandoned after repair, and the condition can be described by a single element at level 3, 2 or 1.

The data describing an element at any level can be categorized in the following subjects:

- Administrative data
- Geometry
- Statics (bearing capacity and safety)
- Materials
- Condition and remaining life
- Maintenance requirements

2.4 Data Base Structure

The system is based on a relational data base in which the individual bridge is the basic unit.

The data base consists of 50 registers, which can be divided into the following logic groups:

- System registers
- Basic registers
- Bridge data registers
- Maintenance alternative registers
- Budget registers
- Index and intermediate registers

o The system registers contain the principal catalogues of information used in the system. Data in these catalogues are constant in the daily use, but can be modified when required.
System registers:
- Element register
- Catalogue of the responsible for bearing capacity
- Catalogue of partners in cooperation

- Catalogue of consultants and their principal staff
- Catalogue of contractors an their principal staff

o The basic registers contain data on the individual bridges. These data are in principle constant for each single bridge after it has been registered. Bridge data can at any time be added, changed or deleted according to the actual number of bridges in the system.
Basic registers:
- Section No./bridge No. register
- Section register
- District register

o Bridge data registers contain administrative, geometric and condition data. The administrative and geometric data are in principle constant in daily use, whereas the condition data reflect the actual condition of each bridge as reported by the inspections. Furthermore, there is a register containing the ranking points as last calculated.
Bridge data registers:
- Administrative/geometric data
- Span lengths
- Maintenance contracts
- Archive register for inspection and repair data
- Material deterioration data
- Element rating data
- Remarks by inspectors
- Ranking points as last calculated

o Maintenance alternative registers contain one or more repair schedules for each bridge. Elements and specific repair works may be listed in any number for the various years. The system calculates the net present value of each maintenance alternative and keeps a list of which alternative is the most economical for each bridge.
Maintenance alternatives registers:
- Maintenance alternatives general data
- Routine maintenance
- Specific repair cost for individual elements
- Cost of delayed traffic for rail and road

o Budget registers contain expenses for the maintenance alternatives.
Budget rgisters:
- Intermediate register used during preliminary budget calculations
- Accepted budget figures for each bridge, which may be overlayed by new budget figures in case budgets are re-calculated

3. CONCEPT AND PERFORMANCE

3.1 The Inventory Module

The user can choose predefined output forms or create individual outputs comprising selected data. A typical predefined form - "Bridge Overview in General" - includes:

- o Bridge number
- o Stationing
- o Bridge name
- o Bridge type (railway, highway or other)
- o Year of construction or major repair works
- o Superstructure type and materials

Querry facilities for selected information are also available. An example could be: All bridges belonging to a certain authority - constructed in the period 1950 to 1960 - with information on:

- o Bridge number
- o Bridge name
- o Superstructure type and materials
- o Current condition marks

Such facilities may be required for the general administration work or for the planning of maintenance and allocation of resources.

3.2 The Inspection and Bearing Capacity Module

The system facilitates inspections to predetermined standards at optimum intervals. Reference data can be printed out for the inspectors and a forecast of conditions as well as remaining life is automatically prepared.

The inspectors may receive data from or report directly to the central database through portable computers.

3.3 The Ranking and Budgeting Module

Ranking points are calculated for each bridge on the basis of data from the Inspector's observations. All bridges are sorted according to their condition and bearing capacity in relation to current loads.

Overall budget requirements are calculated and adjusted to budget restraints. Maintenance strategies for the individual bridges are optimized on the basis of net present value calculations.

4. EDUCATIONAL PROGRAMMES

Educational programmes have been carried out to ensure the succesfull introduction of this new tool into a long established tradition for manual work with data kept in ordinary files.

The educational programmes also covered the standardization of inspection routines.

5. FUTURE TRENDS

The basic concept for the Bridge Management System has been successfully used during the development of similar Management Systems. A Road Management System has been implemented and other subjects for maintenance management is under way.

PC networks for the management of de-centralised systems have already been established.

Currently, we are working on a graphic support to the menus.

Graphic representation of information is under preparation and digital storage of colour pictures (of damages) will be supported when the technology is suitable.