

F. S. Fanous, A. R. Soni, L. F. Greimann

Automated Recording of Bridge Inspection Data in the Pontis Format

Final Report

April 1995

Sponsored by the
Iowa Department of Transportation Highway Division
and the Iowa Highway Research Board

Iowa DOT Project HR-364
ISU-ERI-Ames-95158



Iowa Department
of Transportation

report

College of
Engineering
Iowa State University

The opinions, findings, and conclusions expressed in this publication are those of the author and not necessarily those of the Iowa Department of Transportation.

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ABSTRACT

A large percentage of bridges in the state of Iowa are classified as structurally or functionally deficient. These bridges annually compete for a share of Iowa's limited transportation budget. To avoid an increase in the number of deficient bridges, the state of Iowa decided to implement a comprehensive Bridge Management System (BMS) and selected the Pontis BMS software as a bridge management tool. This program will be used to provide a selection of maintenance, repair, and replacement strategies for the bridge networks to achieve an efficient and possibly optimal allocation of resources. The Pontis BMS software uses a new rating system to evaluate extensive and detailed inspection data gathered for all bridge elements. To manually collect these data would be a highly time-consuming job. The objective of this work was to develop an automated-computerized methodology for an integrated data base that includes the rating conditions as defined in the Pontis program.

Several of the available techniques that can be used to capture inspection data were reviewed, and the most suitable method was selected. To accomplish the objectives of this work, two user-friendly programs were developed. One program is used in the field to collect inspection data following a step-by-step procedure without the need to refer to the Pontis user's manuals. The other program is used in the office to read the inspection data and prepare input files for the Pontis BMS software. These two programs require users to have very limited knowledge of computers. On-line help screens as well as options for preparing, viewing, and printing inspection reports are also available.

The developed data collection software will improve and expedite the process of conducting bridge inspections and preparing the required input files for the Pontis program. In addition, it will eliminate the need for large storage areas and will simplify retrieval of inspection data. Furthermore, the approach developed herein will facilitate transferring these captured data electronically between offices within the Iowa DOT and across the state.

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1. INTRODUCTION

Bridges provide a critical link for transportation systems and economic growth. During the past few years, significant increases in legal loads as well as growth in the volume of traffic and reductions in resources for bridge maintenance have contributed to the deterioration of many of the bridges in the United States. For example, of the approximately 4,000 state-owned bridges in Iowa, more than 20% are classified as structurally or functionally deficient [1]. The percentage of deficient bridges owned by counties and cities in the state of Iowa is approximately 50%. These deficient bridges annually compete for a share of the state's limited transportation budget.

The total cost to bring the condition and load-carrying capability of all bridges in the United States to minimum desired standards would exceed several billion dollars. However, present budgets allow for the expenditure of only a fraction of this cost annually. As some bridges are upgraded and repaired, others move into the deficient bridge category as they continually age and deteriorate. Therefore, to avoid an increase in the number of deficient bridges, either funds must be dramatically increased or present management tools must be improved. For these reasons, the U.S. Department of Transportation has developed legislation that requires states to implement a Bridge Management System (BMS) by October of 1998 in order to be eligible for federal funds [2].

A Bridge Management System would utilize bridge inspection data to predict future structural conditions of bridge elements so that future needs such as personnel and funds can be estimated. This prediction can be accomplished by analyzing several improvement, maintenance, rehabilitation, and replacement options and optimizing the selected option on a network or project level. These advances in BMS coupled with new federal mandates for states to implement BMS have set the stage for the revolution that is now taking place in bridge management.

1.1. Background

The state of Iowa has recognized the need for a comprehensive BMS. The state elected not to develop its own BMS tools but rather adopted the Pontis BMS program [3]. This is one of two major BMS programs developed with state and federal cooperation. The Pontis program was developed by the California Department of Transportation (CALTRANS) under an agreement with the FHWA. The other BMS, referred to as BRIDGEIT, is being developed through the National Cooperative Highway Research Program (NCHRP) by a private consulting firm.

During the summer of 1992, the Pontis BMS program was evaluated by the state of Iowa and 13 other states. Iowa's evaluation was conducted utilizing the beta version of the program and a small set of data for bridges in two counties in the state. As a result of this beta test, several changes were made and Version 2.0 of the program was released in March of 1994 [4]. Currently the program is being revised for easier use and conversion to Microsoft Windows [5].

Although the current National Bridge Inventory (NBI) 0 to 9 condition rating numbers for a bridge deck, superstructure, and substructure [6] are easy to communicate, the Pontis Technical Advisory Committee (TAC) and the Pontis developer agreed that fundamental shortcomings exist with this bridge rating system. In their opinion this system cannot be directly used to build a decision model for the following reasons:

1. Bridge deck, superstructure, and substructure consist of many elements that are constructed using different materials. Each of these elements behaves differently over time and may be affected differently by the surrounding environment. These factors are not reflected in the current NBI rating system.

2. Two elements with the same rating can behave totally differently and may require different maintenance actions. Therefore, just knowing the rating number is not sufficient to specify the required maintenance action.
3. Despite the detailed guidelines that are being used in conjunction with the current rating system, considerable uncertainty is associated with these ratings.
4. The current rating system only gives a relative condition of components and cannot be directly used to investigate the tradeoffs and benefits of various actions.

For these reasons, the Pontis developer and the Pontis TAC agreed that a more extensive inspection system is needed to adequately define the condition of a bridge element. As a result, they developed a rating system that records conditions for approximately 160 elements using a set of three to five condition states that are described in terms that are applicable to each particular element [3]. Further, each element was classified into one of four possible environment conditions. Descriptions of the condition state and environmental conditions are given in Chapter 3 of this report. Collecting these data represents the most time consuming and costly task. Therefore, it is necessary to set up an automated data collection system to help bridge inspectors in gathering bridge inspection data following the Pontis inspection guidelines.

1.2. Objective

The primary objective of this study was to develop an automated-computerized methodology for gathering bridge inspection data for the Pontis management system. The system developed in this project utilizes the state of Iowa numbering system that was developed to define bridge elements.

In addition, it enables bridge inspectors to prepare inspection reports and data files for direct interaction with the Pontis BMS software.

Since much of the information associated with current practices in bridge inspection or in the Pontis rating system is presented in a tabular format, it was necessary to develop the system with flexibility and strong interactive and on-line help capabilities. These capabilities ranged from recording and retrieving information to generating inspection reports. The developed system is mouse driven; however, in the future the system can be revised to utilize pen-based computer technology.

1.3. Research Plan

The objectives of the work presented herein were accomplished by completing the following tasks:

1.3.1. Task 1. Literature Review

An extensive review was conducted of current state-of-the-art technologies in computer hardware and software that can be utilized to accomplish the goals of this work. The search surveyed available software, in particular those products in the public domain.

1.3.2. Task 2. Review of Iowa DOT Computer Capabilities

The objective of this task was not to assess the Iowa DOT computer capabilities but rather to maximize the use of the computers currently available to the DOT personnel. This goal was accomplished via contact with the Iowa DOT Bureau of Information services and the Iowa DOT Bridge Maintenance Office. Findings of this task were considered in developing the data recording

system so that it is compatible with the computers currently used by the Iowa DOT. In addition, recommendations for computer equipment needed for use in the field were made to the Bridge Maintenance Office.

1.3.3. Task 3. Factors Influencing the Developed System

This task was devoted to defining all factors that may influence and guide the structure of the computerized data collection. For example, the potential users and their needs were identified. In addition, data input strategies were examined.

1.3.4. Task 4. System Structure and System Development

The authors of this work were in continuous contact with the Iowa DOT Bridge Maintenance Office as well as members of the project advisory committee during the course of developing this system. A preliminary version of the software was presented to the advisory committee and their recommendations and suggestions were incorporated. In late summer of 1994, a revised version of the system was delivered to the Iowa DOT Bridge Maintenance Office where it was tested. Since then, numerous changes in the program have been made to simplify its use and to generate bridge inspection reports in the format required by Iowa DOT.

2. LITERATURE REVIEW

The most time consuming and costly task for states wanting to utilize the Pontis BMS would be setting up the detailed inspection data. To provide enough details in reporting a condition, the Pontis program categorizes the major components of a bridge into more easily described elements. Several states have already begun using element level inspection reports. However, few have developed an automated procedure for collecting inspection data. The following sections summarize some of the methods used by other states in collecting bridge inspection data in accordance with the NBI or the Pontis inspection guidelines. In addition, electronic techniques that can be utilized in capturing inspection data are summarized.

2.1. Data Collection by Other States

Several state DOTs that use a bridge management tool for their Maintenance, Repair, and Rehabilitation (MR&R) activities were contacted by the authors of this report to determine the procedure for collecting the bridge inspection data. This survey was carried out via telephone communication with bridge maintenance engineers of these states. Table 2.1 summarizes the findings of the survey for only those states that use Pontis as their BMS. The questions that were asked are listed as footnotes.

2.2. State-of-the-Art Technology for Data Acquisition

As the age of electronics and electromagnetism advances, new technologies are being invented for storing information in as easy a manner as possible. Although the authors recognize that several of the techniques presented below might not be suitable for collecting bridge inspection data, they

Table 2.1. Methods of collecting bridge inspection data by other states

DOT (1)	Method of Collecting Data (2)		Input into Pontis (5)	
	Manual (3)	Automated using Software (4)	Manual(6)	Data Files(7)
Arkansas		✓ Alpha-5		✓
Colorado		✓ R base		✓
*Connecticut	✓			✓
Nebraska	✓		✓	
Nevada		✓ DB4		✓
Massachusetts	✓		✓	
Kansas	✓		✓	
New Mexico	✓		✓	
N. Dakota	✓		✓	
Oklahoma		✓ DB4		✓
Tennessee		✓ R base		✓
Wyoming		✓ MS Access		✓
*Wisconsin	✓			✓
West Virginia	✓		✓	
Washington		✓ Fox Pro		✓
Virginia		✓ Visual Basic & MS Access		✓
Texas	✓		✓	
Oregon		✓ Fox Pro		
Minnesota		✓ Paradox		

(1) DOTs using Pontis as BMS
(2) Method of collecting element level data
(3) DOTs using hard copy forms
(4) DOTs using laptop
(5) Method of entering data into Pontis software
(6) Done in Pontis program
(7) Data read into Pontis by data files created using laptop
* The inspection is manual but data are entered through a database

believe that it is beneficial to summarize these methods from the final report on IADOT Project HR-366 [7].

2.2.1. Bar Coding

In bar coding, information is transferred by means of the widths of black bars and the white spaces between them. The permutations and combinations of these bars and spaces result in unique codes for many objects. A scanner or decoder is used to decipher the information stored in a bar code. The speed with which the coded message is interpreted is phenomenal. Bar coding is considered to be the most popular and cost effective of existing automatic identification technologies. The cost of producing labels to mark different items is low, and the devices to read them are also relatively inexpensive. Bar coding is extensively used for asset tracking, inventory control, time and attendance recording, quality control, check-in/check-out, etc. The Iowa DOT's central warehouse is using bar coding along with radio frequency data communications for faster and more accurate receiving, storing, and delivering of parts, materials, and supplies from the central warehouse to other locations within the state. The problems associated with bar coding are label print quality and its durability. Also line-of-sight to the bar code is necessary. These problems make this technique unsuitable for gathering bridge inspection data.

2.2.2. Radio Frequency Identification

Radio frequency identification (RFID) uses a radio frequency (RF) to capture and transmit data. Data are read from tags, mounted on a product, that are within the range of RF reading equipment. RFID characteristics include capability to

- Detect, read, or write on information tags up to 324 feet away.

- Store up to 64,000 bits of alpha and numeric data in each tag.
- Withstand harsh temperatures from -40° F to 400° F.
- Communicate bi-directionally and multi-directionally.

RFID technology is used in material identification, container identification and tracking, automatic guided vehicle control, tolls and fees, etc. This technology has been used to keep track of the railroad cars and locomotives. High cost, lack of flexibility between different manufacturers and the mode of storage and retrieval of data make RFID an inappropriate tool for the desired task.

2.2.3. Magnetic Stripes

In this technology, data are stored on a stripe by magnetizing zones with alternating polarities. The amount of information stored on the stripe is based on the application and on the length of the stripe. The components of this system include magnetic stripe, encoder, reader, and software for programming and decoding. The encoder formats areas of the magnetic stripes in alternating polarizations. The reader is generally stationary and needs to be mounted in a location that can be easy to reach. The software is the interface between the reader and the output data. It converts the magnetic pattern detected by the reader into useful information. This technique is used in credit and personnel I.D. card industries where names and other information can be stored on a magnetic stripe. The limitations on magnetic stripes are security and damage of the magnetized area. Obviously this method cannot be utilized for describing element conditions as required by the Pontis BMS software.

2.2.4. Touch Buttons

This system has features encompassing those of bar coding and RFID technologies. The advantage of touch buttons over bar coding is that they can store more information. Also they

require less storage and have more systemic flexibility than RFID technology. The system consists of the following components:

1. Touch memories: stainless steel button-shaped shells encasing a memory chip and permanent laser identification number.
2. Touch Pens: pen-shaped mobile readers for touch buttons that can transfer data to a touch transporter, another touch pen, or a touch editor.
3. Touch transporters: high-capacity memory devices that act as intermittent holders of data from the touch pens or editors.
4. Touch editors: hand-held computers that can accept data from their keyboards and act as intermediate devices to touch memory, touch pen, or PC to read or write or both.
5. Personal computer: needed at the end of the line to read data from touch editors or touch transporters.

This technology is relatively new and has not been used extensively so far.

2.2.5. Optical Character Recognition

Optical character recognition (OCR) uses machines to read and decode common symbols for further processing. The main components of this technology are a method to input data; a method to transport documents past an OCR scanner; a scanner that converts reflected or transmitted light into electronic signals; a processor to prepare data for postprocessing; feature extraction and classification logic; and output. An example of the use of this technology is recognition of mail pieces by means of a key element like a zip code. This is a good way to transfer data to the computer

because it reduces human error and results in a more accurate database. Obviously this technology cannot be utilized as a convenient approach to collect inspection data for the various bridge elements.

2.2.6. General Purpose Software

Software is the means by which humans ask machines to perform tasks to meet their needs. It consists of a set of instructions that are prepared in a manner to get the desired results. Software is an executable program that manipulates a given set of data in either a batch or an interactive mode. The interactive type of software is in more demand as software is becoming more and more user friendly and self-explanatory. A user executes the program on the basis of a database and then compares, analyzes, and interprets the results that are obtained. Generally, software programs are of the following types: spreadsheets, data management, statistical analysis, and a broad category of customized programs that are developed to perform specific tasks. The components of software include the main program segment, subroutines, functions, and instructions to operate the computer system. Obviously, the use of software makes time-consuming tasks move very quickly. Of course there are certain limitations to what software can do, and also its accuracy must be tested. Software was the approach used by the author of this report to develop the automated collection of bridge inspection data in the Pontis format.

2.2.7. Pen-Based Computer

This system uses the computer and a pen for direct data entry into the computer. With effective handwriting recognition codes, the user may not need to type commands to make the computer work. The computer recognizes the handwritten input and executes the given instructions.

Pen-based computers use the screen and specialized software to interpret the screen-written message. The screen in a pen-based application would resemble a form which is filled in; information entered is stored as desired. With user friendly software it becomes very easy to adapt. However, the biggest drawback of this system is its difficulty recognizing handwriting. Errors at this point could upset the whole purpose that it has to serve. The authors of this report believe that it will not be difficult to revise the software developed in this project to utilize this technology in gathering the IADOT bridge inspection data. However, a special version of Windows for the pen-based capabilities will likely be required.

2.2.8. Voice Recognition

In this technology, sounds and/or words spoken by humans are converted into electrical signals and deciphered to coding patterns that have pre-assigned meanings. The analog signals are then transformed into digital values and decoded. Voice synthesis can be used to verify the correct entry of data and to guide the user through specific tasks. Personal computers are the main processor for recognizing voice. Portable computers are handy tools for in-field inspection using voice recognition. The hardware for these systems is usually hand-held or belt-carried equipment. The software consists of a set of programs that let the user train the voice recognition system. This application seems to be the easiest and the most convenient way to gather bridge inspection data. However, the limitations come in the form of limited vocabulary and problems that may arise from users' different accents.

2.3. Methodology Selected

After review of the various available data collection techniques summarized in the previous section, it was concluded that software (see Sec. 2.2.6) can be developed to help bridge inspectors collect inspection data in the Pontis format. However, it is strongly recommended that other methods that utilize pen-based computers and voice recognition technology be investigated to further simplify gathering inspection data.

3. PONTIS BRIDGE MANAGEMENT SYSTEM

3.1. Background

Bridge management systems are at present cost accounting tools. Capabilities of different systems vary but nearly all systems can identify repair needs, develop approximate cost estimates, and identify structures that need to be repaired. Repair options may be optimized to determine the most cost-effective use for available funds. One of the newly developed BMS that contains these capabilities is the Pontis BMS software which was selected by Iowa DOT as a management tool for the bridges within the state.

The development of the Pontis program was monitored by a Technical Advisory Committee consisting of representatives from the FHWA, the Transportation Research Board, and the states of California, Minnesota, North Carolina, Tennessee, Vermont, and Washington. The committee was also responsible for defining the different elements that affect bridge performance and the condition states of bridge elements as well as the corresponding measures to be taken to improve these conditions. The ultimate goal of the Pontis program is to provide users with the most efficient maintenance, repair, and rehabilitation (MR&R) and improvement policies in order to derive the maximum benefits from the use of available limited funds.

3.2. Major Components of Pontis

The Pontis BMS software consists of several interrelated submodels that handle different parts of capital and maintenance programming analysis. All the required information for these submodels is derived from a centralized database. Recommendations for bridge maintenance activities are made utilizing the four major components shown in the shaded boxes in Fig. 3.1. The following sections

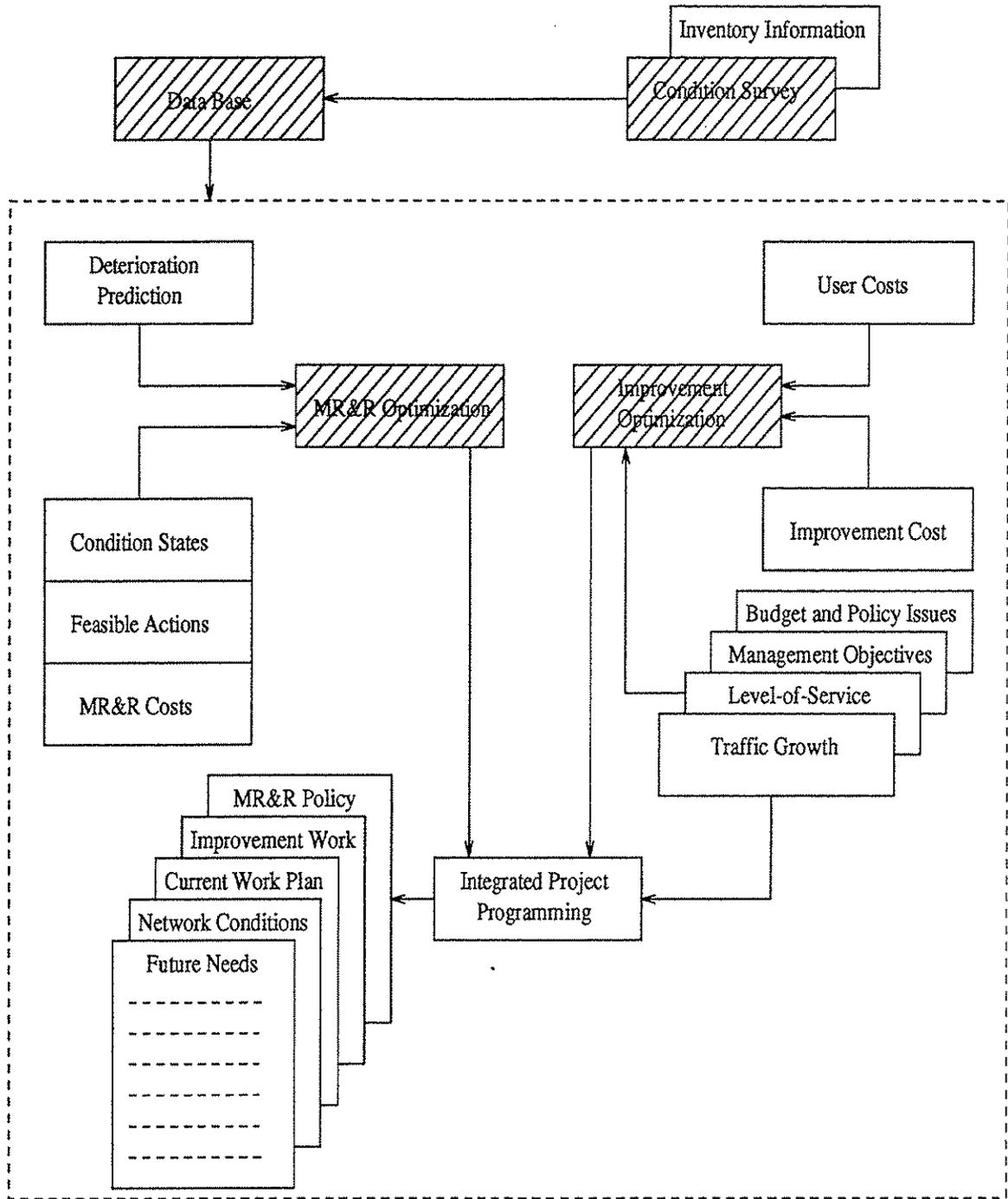


Fig. 3.1 Major Components of Pontis

describe the salient features of the Pontis BMS program. For a complete and detailed understanding of the Pontis software the reader should refer to the Pontis manual [4].

3.2.1. Database

At the heart of the Pontis BMS is a database that includes bridge inventory data, condition state data for bridge elements, maintenance cost, improvement cost, and user's cost. The cost data are gathered from various sources while condition data of a bridge are collected by bridge inspectors. Bridge inspection data are utilized by the Pontis program to predict the future condition of bridge elements. The predicted future condition along with the maintenance cost data are then used to select maintenance strategies for the various elements.

The data relating to the bridges such as the element inspection and bridge level data, are present in subdirectories in the Pontis program. The various subdirectories in the Pontis program with their functions are briefly listed below:

1. Subdirectory Database

This directory contains no files of its own but does contain subdirectories. Each of the subdirectories has a complete set of bridge data and a few other files derived from the bridge data.

2. Subdirectory Input

All files from the inventory or from other sources which are to be entered into the Pontis software are stored in this subdirectory.

3. Subdirectory Output

In addition to the Pontis reports, the program has modules that allow the user to create certain text files that may be used by other software packages such as spreadsheets. When such files are created they are placed in this subdirectory.

4. Subdirectory History

The Pontis BMS has a module to archive bridge data into a format that can be recovered and analyzed in future years; such files are placed in this subdirectory.

5. Subdirectory Report

All Pontis reports are produced in the form of report files and are stored in this subdirectory. These files can be edited or printed utilizing any word processor.

6. Subdirectory Param

This subdirectory contains files that are used in communicating between the menu system and the modules and report programs.

7. Subdirectory Model

The cost models, prediction models, and other specialized modeling files used by the Pontis analytical modules are stored in this subdirectory.

3.2.2. Maintenance, Repair, and Rehabilitation (MR&R) Optimization Model

The Pontis program uses two activities to recommend improvement actions. One activity is related to maintenance, repair, and rehabilitation (MR&R) actions that are performed to repair a deteriorating element to improve its condition which may deteriorate again with time. The Pontis MR&R model uses prediction models and maintenance cost to choose minimum cost strategies for up

to 160 elements per bridge. The other activity is related to improvement actions. The Pontis program addresses these two activities separately and then combines the recommendations for each bridge in the overall network requirements. The MR&R model requires information related to the future condition states, agency costs, and user costs. The features of this model are briefly summarized in the following sections.

3.2.2.1. Prediction Model

This model predicts future conditions of a bridge element using the Markov chain method and considering effectiveness of corrective actions [4]. The Markovian approach is used to estimate the future condition of bridge elements. This approach utilizes transition probabilities that define the probability that an element will deteriorate from one condition to another. These probabilities can be estimated using one of the following:

- 1) The judgment of experts working in the field of bridge inspection. This approach will be necessary for the first few years of Pontis usage until a reliable database becomes available.
- 2) Historical data from two successive inspections of bridge elements. This information will be updated along with the transition probability when new inspection data become available.

3.2.2.2. MR&R Action Costs

The Pontis BMS software requires a file that contains the MR&R cost for each possible action for each element in a defined environment and condition state. The MR&R cost includes the agency and the user costs.

User Costs: User costs are those incurred by the roadway users and can be related to (1) deficiencies that require certain (or all) vehicles to detour a bridge and (2) deficiencies that are associated with increased accident rates.

Factors that need to be considered when gathering user costs are accident rate and vehicle operating costs. The Pontis manual [4] gives relationships to estimate these costs, taking into account factors such as the average daily traffic (ADT) crossing a bridge, cost associated with the type of accident, truck weight limit, posted weight limit, etc. that may affect the estimate of these costs.

Agency Cost: Agency cost is the cost associated with the MR&R actions or improvement action for a bridge element. Information related to feasible actions that can be taken to improve the performance of bridge elements can be gathered from many sources including state maintenance engineers and city engineers as well as bridge maintenance historical data. Some of this information may also be obtained from ref. [8].

3.2.2.3. MR&R Optimization

Whether an element should be allowed to deteriorate further is based on the probability of failure and the replacement cost associated with this element. The idea utilized in the MR&R optimization model is to have a funding program for an element that minimizes the maintenance cost in the long run. Two concepts are involved in this model:

1. The long-term minimum cost policy covers work that if delayed would result in expensive MR&R operation and also actions that if taken would prove to be redundant and as a result expensive.

specific. A possible source of the unit costs associated with some of these improvement actions for Iowa bridges is given in [8].

3.2.4. Integration Model

In the integration model the results from the above-mentioned models are combined into a single recommended bridge-level program. The model uses a benefit/cost ranking system to set priorities based on the funding program eligibility requirements and budgets. If the total MR&R and improvement cost exceeds the replacement cost then replacement would be advised.

The Integrated Programming Model by itself is not an optimization model but a device for bringing the results of the optimization models together and simulating future events according to the criteria set by other models. The integration model results in one of the following actions being scheduled: (a) Do nothing; (b) A project currently in pipeline is programmed; (c) Replacement is programmed; (d) Maintenance or improvement action is programmed. Of these, a project currently in the pipeline gets top priority. Finally, the Pontis program sorts the bridges by the new total benefit/cost ratio and the projects are scheduled on the basis of budgetary constraints.

3.3. Inspection Data for Pontis

The Pontis BMS requires data for a detailed state-level network optimization. Some of this information can be directly obtained from the currently available bridge inventory data. This information includes the bridge_ID, FHWA number, mile post, date of construction, etc.

One of the most important features of the Pontis BMS is the introduction of a detailed statistical profile of the composition and the condition of every bridge in the inventory. Bridges are composed of *elements*, each of which represents a particular type of member (e.g., closed web/box

girder, submerged pile, pourable seal, etc.) made of a particular material (e.g., weathering steel or prestressed concrete). All the parts of a bridge are characterized in this way. The Pontis manual gives a list of all elements that can exist in all types of bridges. Certain features such as scour and rust are tracked in Pontis by means of Smart Flags, which are discussed in Chapter 4. However, every DOT intending to use the Pontis program needs to identify the elements that exist in the bridges of that state. Then the Pontis BMS can be customized for each state to include these elements along with state-specific user and agency costs.

3.3.1. Condition State of a Bridge Element

When a bridge is inspected, each element is rated in one of three to five condition states. The Pontis manual [4] lists the condition states for the 160 elements identified by the Pontis BMS. Conditions of bridge elements can transfer from one state to another as a result of deterioration and lack of maintenance. These condition states need to be defined by the DOTs of respective states for the elements that exist in that state's bridge population. Once units are defined for each element, the total quantity of the element is distributed among any or all of the condition states on a percentage basis.

3.3.2. Environmental Condition

The behavior of each bridge element over time is governed by the environmental and random effects of traffic and the bridge age. To take these effects into account, each element is placed in one of the four environmental conditions. The Pontis manual [4] defines these conditions as benign, low, moderate, and severe. According to the Pontis manual the environmental designation cannot change as the result of maintenance actions.

2. Network wide, any given condition state has elements passing into it and out of it because of deterioration and actions taken on the element. Thus the network wide distribution of an element among its condition states must be constant from year to year in order for a policy to be sustainable in the long term.

In MR&R optimization essentially three things may take place:

1. Bridge elements deteriorate, making transitions from one condition state to another, "worse one." This is modeled by the do-nothing transition probabilities.
2. Actions are taken on specific bridge elements, incurring a cost which is quantified in the MR&R cost file.
3. Based on the transition probability model, action taken causes an improvement in the condition. Thus the optimization implies long-term policy which minimizes expenditure by the agency while satisfying the requirement of a steady state.

3.2.3. Improvement Model

This model identifies and prioritizes potential improvement actions, including widening, raising, strengthening, or replacing with a functionally superior structure. These decisions are based on user-cost savings and level-of-service standards, subject to budget constraints.

For any investment made for improvement, the user should derive maximum benefits. The important actions include widening, raising, and a set of user-defined specific actions depending on the state DOT's requirements. Replacement of a unit or an entire bridge is also accounted for in the improvement consideration along with MR&R considerations. Cost of improvement action is state

3.4. Interface to Other Systems

As can be seen, building a complete Pontis database would require a number of years. The bridge-level data such as the ADT, mile post, and FHWA number are present in the NBI inventory. A software interface can be developed to download the necessary data from the NBI inventory to the Pontis database. The element-level data have to be updated after every inspection. Also the user cost and the agency cost have to be updated to reflect inflation and other factors. These two tasks can be performed outside the Pontis BMS software by utilizing other software to prepare data files in the Pontis format so that they can be used directly in conjunction with the Pontis software. Chapter 5 of this report summarizes the software that was developed herein to electronically capture and prepare inspection data files in the Pontis format.

4. PONTIS AS IOWA DEPARTMENT OF TRANSPORTATION BMS

As previously mentioned, the Pontis BMS program was evaluated by the state of Iowa and thirteen other states. Iowa's evaluation was conducted using the beta version of the Pontis BMS in conjunction with a small set of data for bridges in two counties in the state. Based on the results, the Iowa DOT has selected the Pontis program as a BMS for the state of Iowa. As of today, the Iowa DOT is still in the process of developing and customizing the Pontis program to meet all requirements specified by the Iowa DOT Bridge Maintenance Office.

4.1. Customization of Pontis Elements

At the Pontis beta test meeting in Orlando in December 1992 it was agreed to form a Commonly Recognized (CoRe) element task group [9]. The reason for establishing the task group was to standardize the bridge elements used by Pontis so that different using states can share common element deterioration rates and cost data. These elements were grouped as commonly recognized (CoRe) elements. The identification of the CoRe elements also serves as a step in standardization of Pontis for an AASHTO software program that would be a standard package used by different states [9]. The task group also defined a set of sub-elements that were not common to all states. Elements not included in the CoRe and sub-element categories were classified as non-CoRe elements. Certain features or characteristics of a bridge that could not be considered as elements but are important to be considered during inspection were identified as Smart Flags.

States are allowed to add sub-elements or non-CoRe elements, but the basic group of CoRe elements remains the standard determined by the task group. The detailed listing and reasons for

being considered as CoRe element or sub-element are presented in [9]. The following sections discuss in brief the nature and characteristics of these groups of elements.

4.1.1. CoRe Element

CoRe elements refer to commonly recognized elements that can be used to share cost, maintenance action, deterioration rates, etc. among the states. In defining the CoRe elements certain factors were considered such as the element definition, element description, condition state language and feasible actions, units of measurements, and elements' relationship to NBI if any. This kind of standardization helps to define the limits of customization of Pontis. Another purpose served by the CoRe elements is to identify all elements that may influence federal funding apportionments. All elements (e.g., girders, trusses, arches, pin and hangers, decks, etc.) which presently and in the future (e.g., joints and bearings) would influence current NBI ratings are identified as CoRe elements. These elements are the same for all states and can be used to convert Pontis element level data into the corresponding NBI codes. A complete list of CoRe elements with the condition states and the feasible improvement actions is presented in [9].

The Pontis BMS has assigned element numbers for all possible bridge elements. However, the element numbers assigned to CoRe elements by the Pontis task group [9] are different from the original Pontis element numbers. Furthermore, the IADOT has adopted a different numbering scheme for the bridge elements. Since the Pontis BMS software recognizes only the numbers that were hard-coded into the program, it is necessary to convert the assigned CoRe or sub-elements and IADOT element numbers to the Pontis element numbering scheme prior to using the Pontis program as a management tool.

4.1.2. Sub-Elements

The task group realized that certain elements were important enough to be classified as CoRe elements but that not all the states like to track these elements. Also a smaller number of CoRe elements will facilitate easier conversion formulas from Pontis to NBI. For these reasons the task group introduced another group of elements referred to as sub-elements. The criteria used to define the sub-elements included the following:

- The condition language and feasible actions must remain the same as for the corresponding CoRe elements.
- The units of measurement must remain the same as for the corresponding CoRe elements.
- Physical size, location, and exposure may be the reasons for stratifying to sub-elements.

Sub-elements can be used to track specific elements such as exterior girders. The Task Group clearly mentioned that whenever sub-elements are used, the corresponding CoRe element should NOT be used in the Pontis database for that specific location of the element. For example, when a portion of a steel girder is classified as a CoRe element and some of the portion is listed as exterior girder, the quantity in each condition state for these portions must be added to give the total quantity for this steel girder. For sub-elements, the condition states and feasible actions are the same as for the corresponding CoRe element. In addition, the units in which the sub-element exists also remain the same as for CoRe elements.

4.1.3. Smart Flags

During the test period of the Pontis beta version, it was noted that some factors such as scour, fatigue, and seismic activity, which may affect the structural performance of a bridge, were not

Pontis-related elements. These conditions are critical to each structure and need to be considered in making maintenance decisions. These factors are handled separately in the Pontis program.

As the CoRe element task force looked at the various forms of deterioration and problems in bridges, it became apparent that flags could be utilized to track those unique problems. To give states the ability to track different distressed phenomena in bridge elements, a smart flag option was introduced. Flags are set up for use in Pontis as a method to identify local problems that cannot be modeled in the Pontis BMS and that do not have a logical pattern of deterioration. In the Pontis program, smart flags operate as if they are elements, having a number and a condition rating. However, they have neither feasible actions nor costs associated with them and are therefore excluded from the MR&R modeling. However, smart flags can provide data that are needed for possible future enhancements of the Pontis models, and it is possible that future versions of the Pontis BMS may provide the ability to associate feasible actions and cost with these smart flags to improve the MR&R model [4, 9].

4.1.4. Non-CoRe Elements

Many elements suggested by various states as possible CoRe elements were not included for the various reasons mentioned in Sec. 4.1.1. These elements include tunnels, rigid frames, stop protection, connectors for steel frames, etc. A detailed listing and the reasons for not considering these elements as CoRe elements is given in [9].

4.2. Classification of Elements for Iowa DOT

Many of the elements mentioned in the Pontis manual [4] are not used by the Iowa DOT, and some of those used by the Iowa DOT are not mentioned in Pontis. Therefore, it was decided to

identify the elements as well as the smart flags that exist in the bridges around Iowa. Many elements were classified as CoRe elements. To account for the other elements that exist in a bridge, the IADOT came up with a numbering scheme of its own. With the help of the Iowa DOT Bridge Maintenance Office, all the IADOT elements were classified into the following groups:

- Deck, slab, or box
- Superstructure
- Substructure
- Other bridge elements
- Culverts
- Smart flags

Each of these categories was further subdivided into groups, and each group was further divided to subgroups, and the bridge elements in each subgroup were defined. This classification was necessary to help the bridge inspector and to simplify the procedure to select bridge elements when conducting bridge inspections. The detailed classification of these groups is given in Table 4.1.

4.3. Utilizing the NBI data

As previously stated, certain information regarding bridge level data is required by the Pontis program. Most of this data such as bridge_ID, the FHWA number, the location of the bridge, etc. exist in the NBI data of the IADOT. To assist the IADOT bridge management personnel, this information was downloaded from the mainframe to PC files. This was accomplished utilizing a computer program that was developed for this purpose. The downloaded data were saved in files to be used later when performing bridge inspection as discussed in Sec. 5.3.2.2.

Table 4.1. Classification of the IADOT elements

<u>Element</u>	<u>Element Number</u>	<u>Element Description</u>
<u>DECK, SLAB, OR BOX</u>		
Concrete		
Protected Deck	111	Concrete deck - Protected with coated bars (top mat)
	113	Concrete deck - Protected with coated bars (both mats)
	115	Concrete deck - Protected with dense concrete overlay
	118	Concrete deck - Protected with dense concrete overlay and coated bars
	120	Concrete deck - Protected with cathodic protection
Unprotected Deck	101	Concrete deck - Unprotected (uncoated bars and no overlay)
	104	Concrete deck - Protected with asphalt overlay
Protected Slab	112	Concrete slab - Protected with coated bars (top mat)
	114	Concrete slab - Protected with coated bars (both mats)
	116	Concrete slab - Protected with dense concrete overlay
	119	Concrete slab - Protected with dense concrete overlay and coated bars
Unprotected Slab	102	Concrete slab - Unprotected (uncoated bars and no overlay)
	105	Concrete slab - Protected with asphalt overlay
Protected Box	117	Concrete box - Protected with dense concrete overlay
	121	Concrete box - Protected with cathodic protection
Unprotected Box	103	Concrete box - Unprotected (uncoated bars and no overlay)
Bottom of Deck, Slab, or Box	131	Bottom of deck, slab, or box
Timber		
	141	Wood deck
	142	Timber slab
Steel		
	151	Open grid

<u>Element</u>	<u>Element Number</u>	<u>Element Description</u>
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SUPERSTRUCTURES

Steel Elements

I-Beam or Girders	161	Unpainted steel I-beam or girder
	171	Steel I-beam or girder painted with inorganic zinc with vinyl topcoat (may include waterborne acrylic)
	191	Steel I beam or girder painted with inorganic zinc only
	201	Steel I beam or girder painted with epoxy aluminum
	221	Steel I beam or girder painted with red lead
Floorbeam	172	Steel floorbeam painted with inorganic zinc with vinyl topcoat (may include waterborne acrylic)
	192	Steel floorbeam painted with inorganic zinc only
	202	Steel floorbeam painted with epoxy aluminum
	222	Steel floorbeam painted with red lead
Stringer	173	Steel stringer painted with inorganic zinc with vinyl topcoat (may include waterborne acrylic)
	193	Steel stringer painted with inorganic zinc only
	203	Steel stringer painted with epoxy aluminum
	223	Steel stringer painted with red lead
Through Truss excluding bottom chord	174	Steel through truss excluding bottom chord painted with inorganic zinc with vinyl topcoat (may include waterborne acrylic)
	204	Steel through truss excluding bottom chord painted with epoxy aluminum
	224	Steel through truss excluding bottom chord painted with red lead
Bottom Chord through Truss	175	Steel Bottom chord through truss painted with inorganic zinc with vinyl topcoat (may include waterborne acrylic)
	205	Steel bottom chord through truss painted with epoxy aluminum
	225	Steel Bottom chord through truss painted with red lead
Pony Truss excluding Bottom Chord	176	Steel Pony truss excluding bottom chord painted with inorganic zinc with vinyl topcoat (may include waterborne acrylic)

<u>Element</u>	<u>Element Number</u>	<u>Element Description</u>
	206	Steel pony truss excluding bottom chord painted with epoxy aluminum
	226	Steel pony truss excluding bottom chord painted with red leaf
Bottom Chord Pony Truss	177	Steel bottom chord pony truss painted with inorganic zinc with vinyl topcoat (may include waterborne acrylic)
	207	Steel bottom chord pony truss painted with epoxy aluminum
	227	Steel bottom chord pony truss painted with red lead
Deck Truss	178	Steel deck truss painted with inorganic zinc with vinyl topcoat (may include waterborne acrylic)
	208	Steel deck truss painted with epoxy aluminum
	228	Steel deck truss painted with red lead
Arch	179	Steel arch painted with inorganic zinc with vinyl topcoat (may include waterborne acrylic)
	209	Steel arch painted with epoxy aluminum
Reinforced Concrete Elements	251	Reinforced concrete beam
	252	Reinforced concrete box
	253	Reinforced concrete box-exterior walls
Prestressed Concrete Elements	241	Prestressed concrete beam
Timber Elements	271	Timber beam
	272	Timber floorbeam
	273	Timber stringer

SUBSTRUCTURES

Steel Elements

Pier Cap	180	Steel pier cap painted with inorganic zinc with vinyl topcoat (may include waterborne acrylic)
	210	Steel pier cap painted with epoxy aluminum
	229	Steel pier cap painted with red lead
Abutment Cap	181	Steel abutment cap painted with inorganic zinc with vinyl topcoat (may include waterborne acrylic)

<u>Element</u>	<u>Element Number</u>	<u>Element Description</u>
	211	Steel abutment cap painted with epoxy aluminum
	230	Steel abutment cap painted with red lead
H-Pile	182	Steel H-pile painted with inorganic zinc with vinyl topcoat (may include waterborne acrylic)
	212	Steel H-piling painted with epoxy aluminum
	231	Steel H-pile painted with red lead
Shell-Piling	183	Steel shell painted with inorganic zinc with vinyl topcoat (may include waterborne acrylic)
	213	Steel shell piling painted with epoxy aluminum
	232	Steel shell piling painted with red lead
Backing Wall	184	Steel backing wall painted with inorganic zinc with vinyl topcoat (may include waterborne acrylic)
	214	Steel backing wall painted with epoxy aluminum
	233	Steel backing wall painted with red lead
Reinforced Concrete Elements		
Abutment	254	Reinforced concrete stub abutment
	255	Reinforced concrete full abutment
	256	Reinforced concrete integral abutment - prestressed and steel beam or girder
	257	Reinforced concrete integral abutment - slab
	258	Reinforced concrete abutment cap - trestle pile
	259	Reinforced concrete backwall (used with the stub abutment)
Pier Cap	260	Reinforced concrete pier cap - trestle pile
	261	Reinforced concrete pier cap - column pier
	262	Reinforced concrete pier cap - solid pier or shaft of a T-pier
Pier	263	Reinforced concrete pile - trestle bent
	264	Encased reinforced concrete pile - trestle bent
	265	Reinforced concrete column
	266	Reinforced concrete pier wall or shaft of a T-pier
	267	Reinforced concrete abutment backing wall
Prestressed Concrete Elements	242	Prestressed concrete pile - trestle bent

<u>Element</u>	<u>Element Number</u>	<u>Element Description</u>
Timber Elements	274	Timber pier or abutment cap
	275	Timber pile
	276	Timber abutment backing wall
<u>OTHER BRIDGE ELEMENTS</u>		
Pin & Hanger Assemblies	281	Pin
	282	Pin and hanger
Bearings	291	Elastomeric (not the ones used in enclosed bearing)
	292	Sliding painted steel plate
	293	Sliding galvanized steel plate
	294	Bearing-rocker
	295	Bearing-roller
	296	Bearing-fixed
	297	Bearing-pot
	298	Bearing-disk
Expansion Joints	301	Strip seal expansion joint
	302	Pourable/filler joint seal
	303	Compression joint
	304	Open expansion joints
	305	Steel finger joints
	306	Sliding steel plate joint
	307	Modular joint
Bridge Railings	311	Steel bridge railing
	312	Concrete bridge railing
	313	Timber bridge railing
	314	Aluminum bridge railing
Approach Slabs	321	Approach slab-concrete
<u>CULVERTS</u>		
Steel	351	Steel culvert
Concrete	352	Concrete culvert

<u>Element</u>	<u>Element Number</u>	<u>Element Description</u>
<u>SMART FLAGS</u>		
Impact Damage	331	Smart flag, impact damage - prestressed beam
	332	Smart flag, impact damage - steel I-beam or girder
	333	Smart flag, impact damage - through or pony truss
	334	Smart flag, impact damage - concrete beam or box
Other Smart Flags	335	Fatigue cracks and fatigue crack prone
	336	Steel - connections
	337	Pack rust
	338	Pin and hanger distress
	339	Top of deck cracking (without PC overlays)
	340	Bottom of deck, slab, or box
	341	Strip seal deterioration (deck expansion joints)
	342	Compression joint deterioration (deck expansion joints)
	343	Smart flag, vertical cracks for solid piers
	344	Scour
	345	Abutment scour
	346	Epoxy injection - concrete deck

5. USER MANUAL FOR THE DATA COLLECTION PROGRAMS

The software developed to capture the bridge inspection data in the Pontis BMS format consists of two programs. The first is the Automated Data Collection (ADC) program, used in the field to gather bridge inspection data. In this program the user is required to follow the steps as defined in the main menu. The gathered information will be stored in a temporary file designated by the bridge FHWA number. This temporary file allows the user to terminate and restart the inspection procedure at any time. The function of the second program, the Pontis Data File Creation (PDFC) program, is to prepare input files for the Pontis BMS software. These two programs were developed utilizing the Microsoft Visual Basic [10] software which allows the user to execute these programs from the Windows environment. Execution of the software does not require the user to have a strong computer background but does require minimum knowledge about Windows and the Notepad application of Windows. In addition, the user needs to be familiar with the Pontis inspection procedure.

5.1. Hardware and Software Requirements

Using the ADC and the PDFC programs requires

- A 386 or higher 100% IBM compatible computer with a minimum of 4 MB of RAM.
- A hard disk drive with at least 12 MB of disk space.
- VGA or higher resolution monitor.
- DOS 3.3 or higher.
- Windows 3.1.
- A printer supported by Windows.

5.2. Installing ADC and PDFC for Windows

To install the ADC and PDFC programs on a computer, follow the steps listed below:

1. Turn on the computer.
2. Type Win at the DOS command prompt to start Windows (if not in Windows).
3. Insert the disk containing the ADC or PDFC programs in the computer floppy disk drive: either drive A or drive B.
4. From the program manager's file menu choose *File* by clicking the mouse once on *File* (see Fig. 5.1).
5. Click on *Run* from the sub-menu options to open the Command Box as seen in Fig. 5.1.
6. On the Command Line type A:\setup or B:\setup where A or B is the drive where you loaded the disk containing the ADC or the PDFC program.
7. Follow the on-screen instructions.

This installation procedure will create subdirectories C:\ADC and C:\PDFC. Files that are required for the execution of each program will be stored in these subdirectories. Icons labeled ADC and PDFC will also be created and added to the Windows Program Manager.

5.3. Automated Data Collection (ADC) Program¹

The Automated Data Collection (ADC) program to collect bridge inspection data can be divided into two parts. Part 1, which deals with defining general bridge information and element selection as summarized in Sections 5.3.1 through 5.3.3, can be accomplished in the office.

¹*Bold* and *Italic* words represent the options available in top level bar of the main menu while *Italic* words represent options in the second level windows.

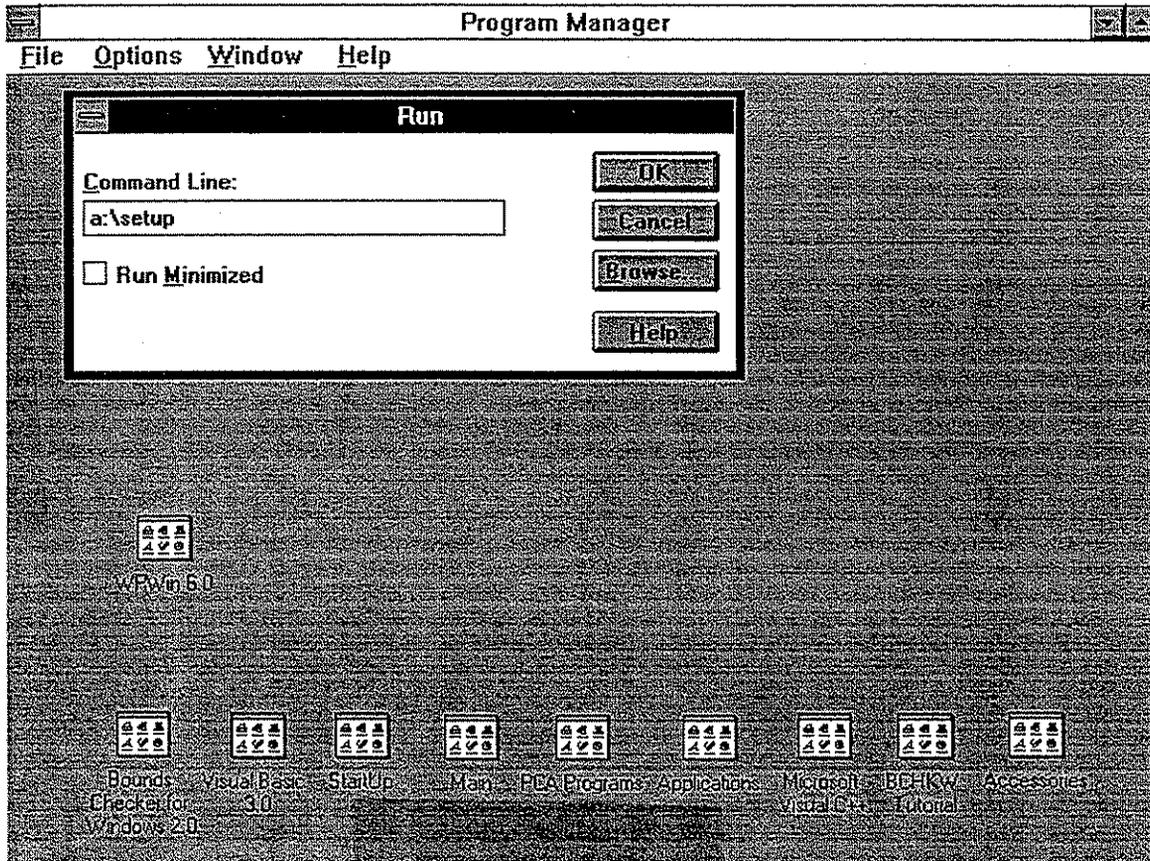


Fig. 5.1 Installing the Programs in Windows Program Manager

Part 2, which relates to collecting the bridge inspection data, is to be performed in the field.

The user must save any data provided in a temporary file as explained in Sec. 5.3.2.3 prior to exiting or terminating the program at any stage during performing an inspection. This file can then be used to resume the inspection.

5.3.1. Getting Started with Field Inspection

To start the ADC program, double click on the ADC icon in the Program Manager (or in the program group in which this icon is present). A welcome screen will be displayed. To proceed with the program, press any key or the space bar on the keyboard. This will open the menu screen shown in Fig. 5.2.

The two menus shown in Fig. 5.2 can be displayed at any time during the execution of the ADC program by clicking on *Help* in the top level menu bar. To obtain information about the steps to be followed to execute the ADC program click once on *About the Program* under the *Help* option. For explanation of the different menu options, click on *About the Menu* under the *Help* option. At any stage in the ADC program the user can obtain help regarding the different windows in the program by clicking on the *Help* button in the particular window that is being used.

5.3.2. Starting an Inspection²

Prior to starting a bridge inspection data collection, the user needs to minimize or close the help windows shown in Fig. 5.2. This can be done by double clicking on the box in the top left corner or on the button labelled *Cancel* at the bottom of each window. The user can begin a new inspection

² If at any point the user wishes to exit the program temporarily without losing the inspection data, the data should be saved in a file as explained in Sec. 5.3.2.3.

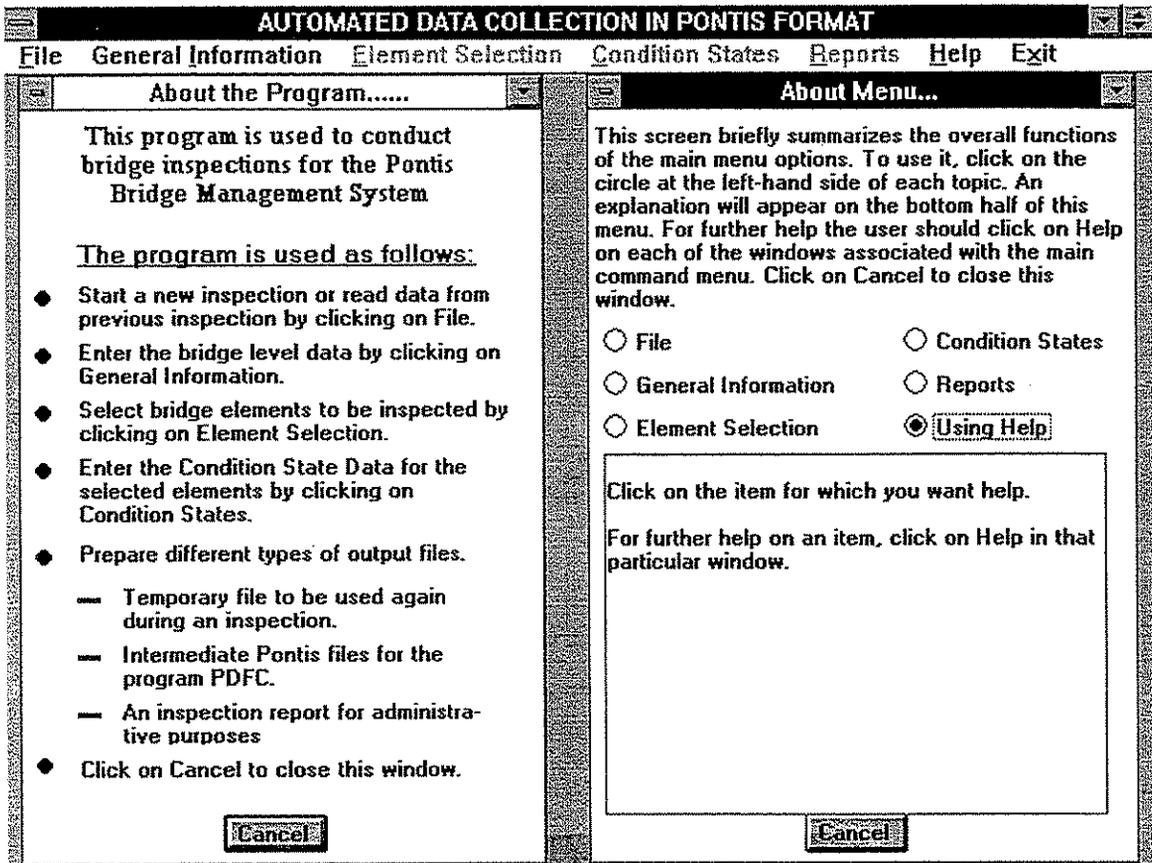


Fig. 5.2 Getting Started with Bridge Inspection

or resume an incomplete inspection by clicking on *File* in the top level menu bar and then selecting the appropriate option as explained in Sec. 5.3.2.1 or Sec. 5.3.2.2.

5.3.2.1. Input new bridge data

To begin a new inspection the user needs to follow the steps outlined below:

- Click on *File*.
- From the drop-down list of options, click on *New Inspection*. The window shown in Fig. 5.3 will be displayed on the screen. This window contains general information related to bridge location, bridge_ID, FHWA number, residency number, inspector's name, inspection date, etc. All files created by the ADC program will be designated by the bridge FHWA number and will be stored in a subdirectory represented by residency number of the bridge.
- An alternative way to start a new inspection is to click on *General Information* in the top level menu bar. This option is available only when there has been no prior inspection during the execution of the program.

The user needs to provide the information listed in the window as shown in Fig. 5.3. Use the tab key to move the cursor from one data field to another. To change the data provided at a particular field, the user needs to position the mouse arrow at that location and click on the left mouse button to start editing the information. The *Clear* button shown in the window will delete the entire field of information. When input of the bridge level data is completed, the user needs to click on the *Ok* button.

Notice a small window showing the bridge_ID will appear on the top right side of the screen. This window will remain as an identifier until the inspection procedure is completed.

AUTOMATED DATA COLLECTION IN PONTIS FORMAT

File General Information Element Selection Condition States Reports Help Exit

General Bridge Information

You may use the tab key to move through the window

Bridge_ID 0344.3S076 Res. No. 24 FHWA No. 013691

a 66 ft X 44 ft Type : Prestressed Beam

carrying route Iowa #7 over Small Natural Stream

located 5.6 miles S of Minnesota State Line

Date of Inspection 3/11/94

Inspector's Name Roger Walton

Fig. 5.3 General Bridge Information

5.3.2.2. Resuming an inspection

To continue an incomplete inspection the user needs to perform the following steps:

- Click on *File*
- Click on *Resume an Inspection*. This will open the window shown in Fig. 5.4. The user can then select the drive, directory, and subdirectory having the residency number of the bridge as explained in Appendix A.
- From the directory or subdirectory selected in the step above, select the appropriate file designated by the bridge's FHWA number. This file contains the incomplete bridge inspection data.
- Click on *Read Data from Temporary File*.

The user needs to verify the bridge level data prior to proceeding to complete the required bridge inspection as explained in the following sections.

5.3.2.3. Saving the inspection data to a temporary file

If an inspection of a bridge cannot be completed and the user wishes to exit the ADC program it is necessary to save any data provided in a file so that the inspection can be resumed at a later stage. Figure 5.5 and the following steps explain how the user can accomplish this task.

- Click on *File* from the top level menu bar.
- Click on *Save to Temporary File*. This will open the window shown in Fig. 5.5. The user can then proceed to select the drive and/or the directory (or subdirectory) where the file has to be saved, as explained in Appendix A. If the directory or subdirectory having the residency number of the bridge does not exist, the ADC program will create one on the chosen drive or directory, respectively.

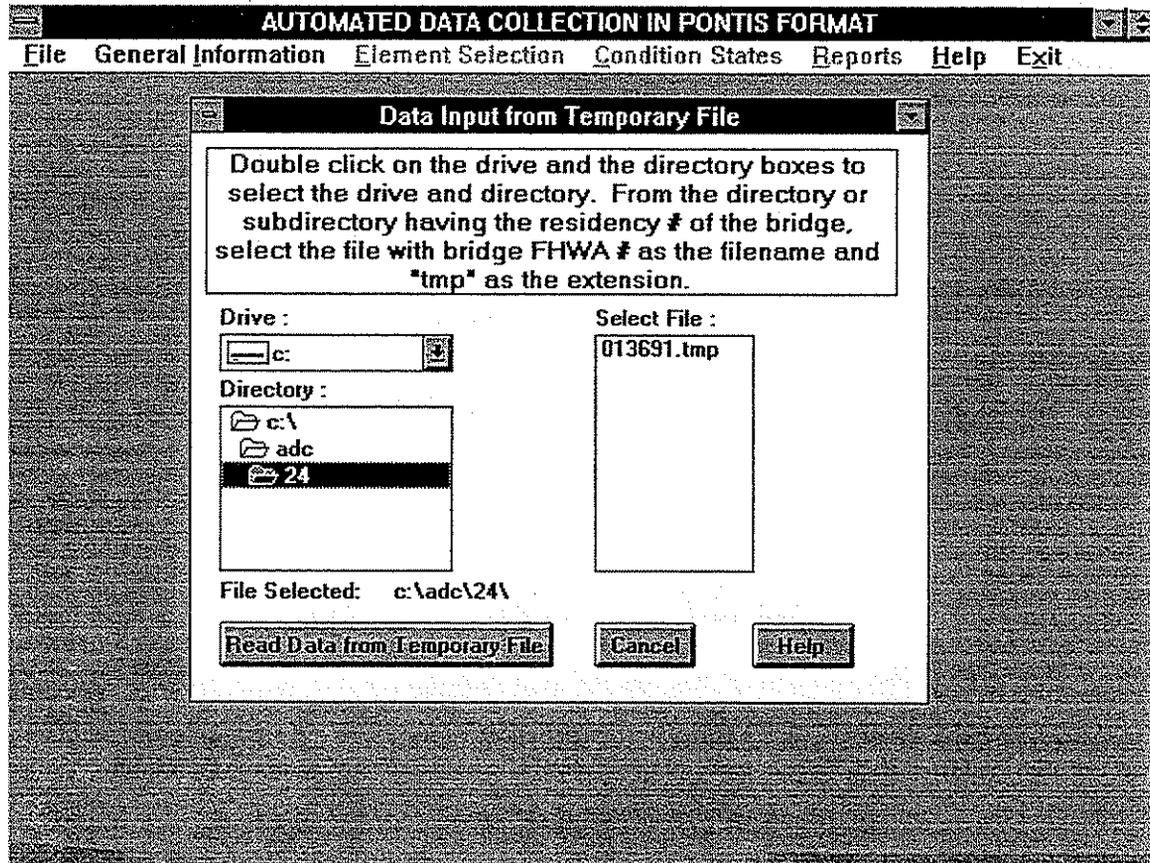


Fig. 5.4 Data Input from a Temporary File

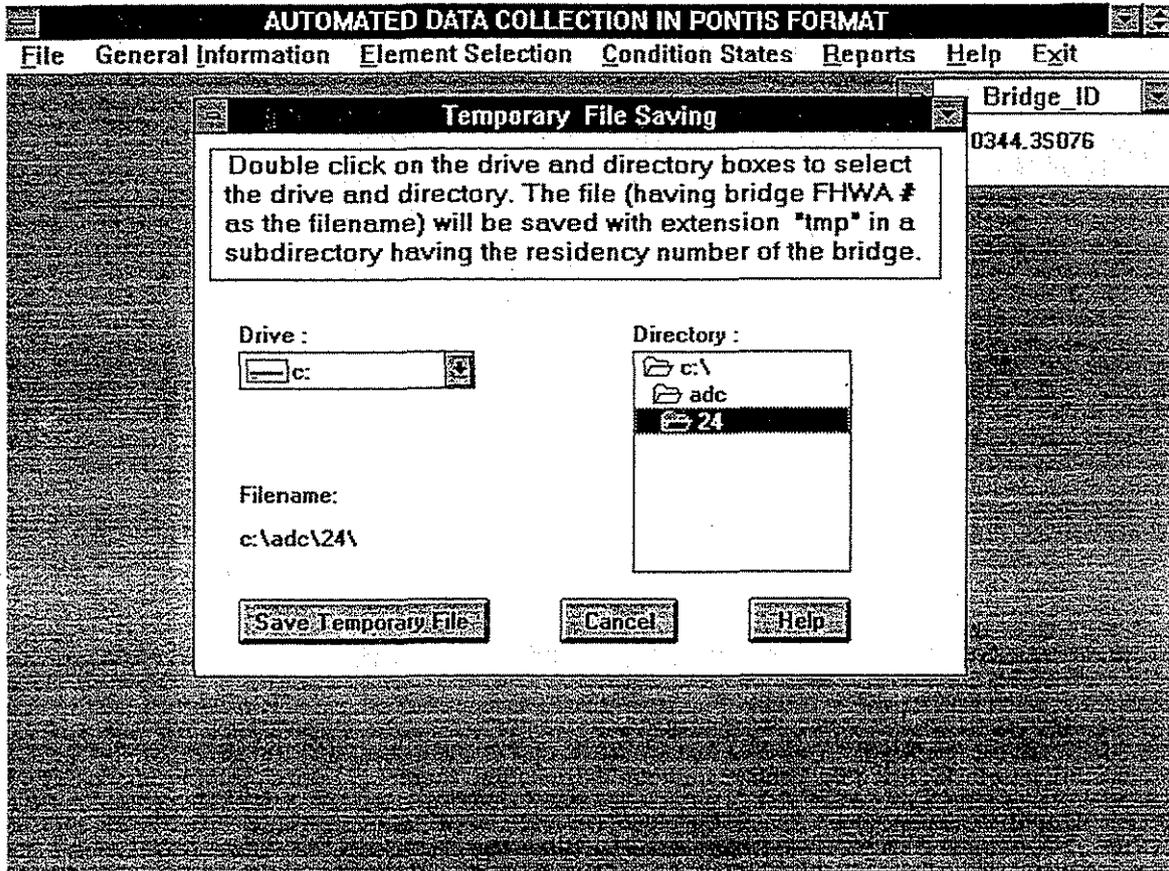


Fig. 5.5 Saving the Inspection Data to a Temporary File

- Click on *Save Temporary File*. The inspection data will be saved in a file designated by the bridge's FHWA number, with extension tmp, in the directory or subdirectory selected in the step above.

5.3.3. Element Selection

To define bridge elements, click on *Element Selection* in the top level menu bar. This will allow the user to choose one of the two alternatives available to select bridge elements for the bridge being inspected (see Fig. 5.6). One option is to use the *General Element List* and the other is to utilize the *Classified Element List*.

5.3.3.1. Using the General Element List Option

If the user selects the *General Element List* to define the elements in the bridge to be inspected, the window depicted in Fig. 5.7 showing a list of all the elements as defined by the IADOT will be displayed.

The elements are arranged in ascending order based on the IADOT numbering scheme. One can select bridge elements by following the steps listed below:

- Use the scroll bar on the right side of the window to scroll down the element list.
- To select an element, click once on the box that appears to the left of the element. The background color of the box describing the element will change, indicating that the element has been selected.
- To unselect an element, click on the box on the left side of the element name again. The checkmark shown in that box will disappear and the background color of the element name is restored to its initial status.

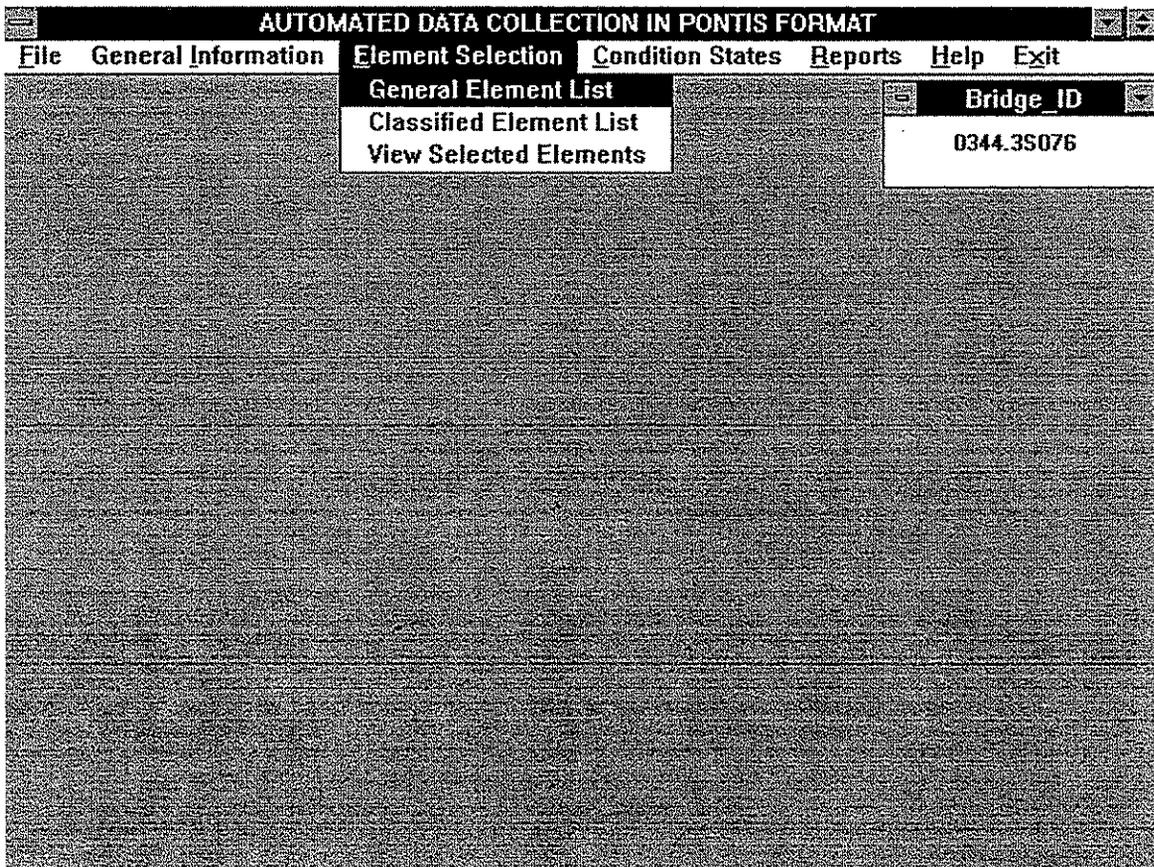


Fig. 5.6 Element Selection

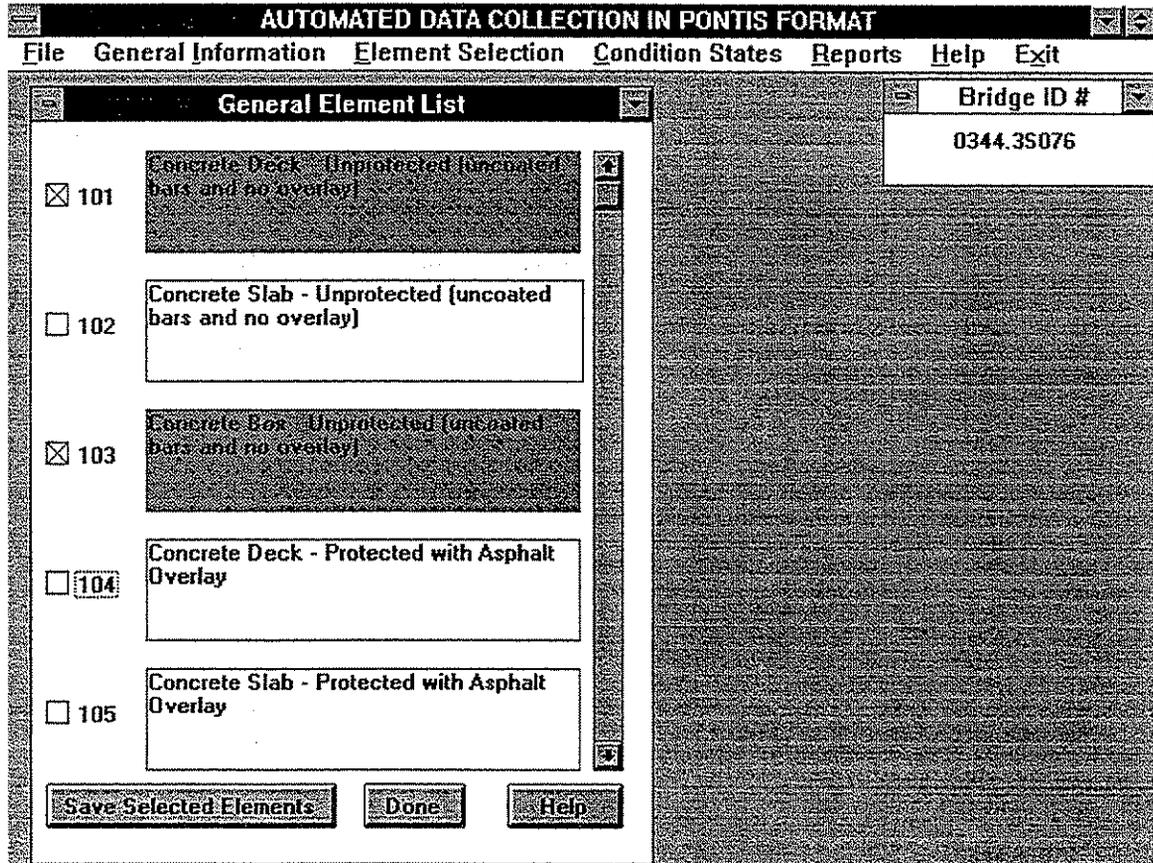


Fig. 5.7 General Element List

- To save the selected elements click on *Save Selected Elements*.
- When the element selection is completed, click on *Done* to exit this window.

5.3.3.2. Using the Classified Element List Option

If the user selects the *Classified Element List* from the drop-down options under *Element Selection*, a window (see Fig. 5.8) classifying the bridge in six groups will appear on the left side of the screen. From these six classifications, appearing in the window titled *Main Group*, the user has to narrow the selection by virtue of the bridge type, superstructure, substructure, deck, etc. For example, if the user chooses *Deck, Slab, or Box*, a window will be displayed classifying the superstructure into different categories. If the user selects one of these categories, another window with further options appears, and so on as shown in Fig. 5.8.

To select the desired element, the user should make subsequent selections through the cascading windows until a list of all elements to be inspected is reached. The procedure for selecting an element from a particular list remains as explained in Sec. 5.3.3.1. To make further selections, the user may need to go to the appropriate level of the cascading windows again. This can be accomplished by clicking on the window that the user desires to use.

5.3.3.3. View Selected Elements

Prior to defining the condition states of the selected elements, it is recommended that the user view the selected elements to ensure that all elements of the bridge to be inspected have been chosen.

This can be accomplished as follows:

- Click on *Element Selection*.

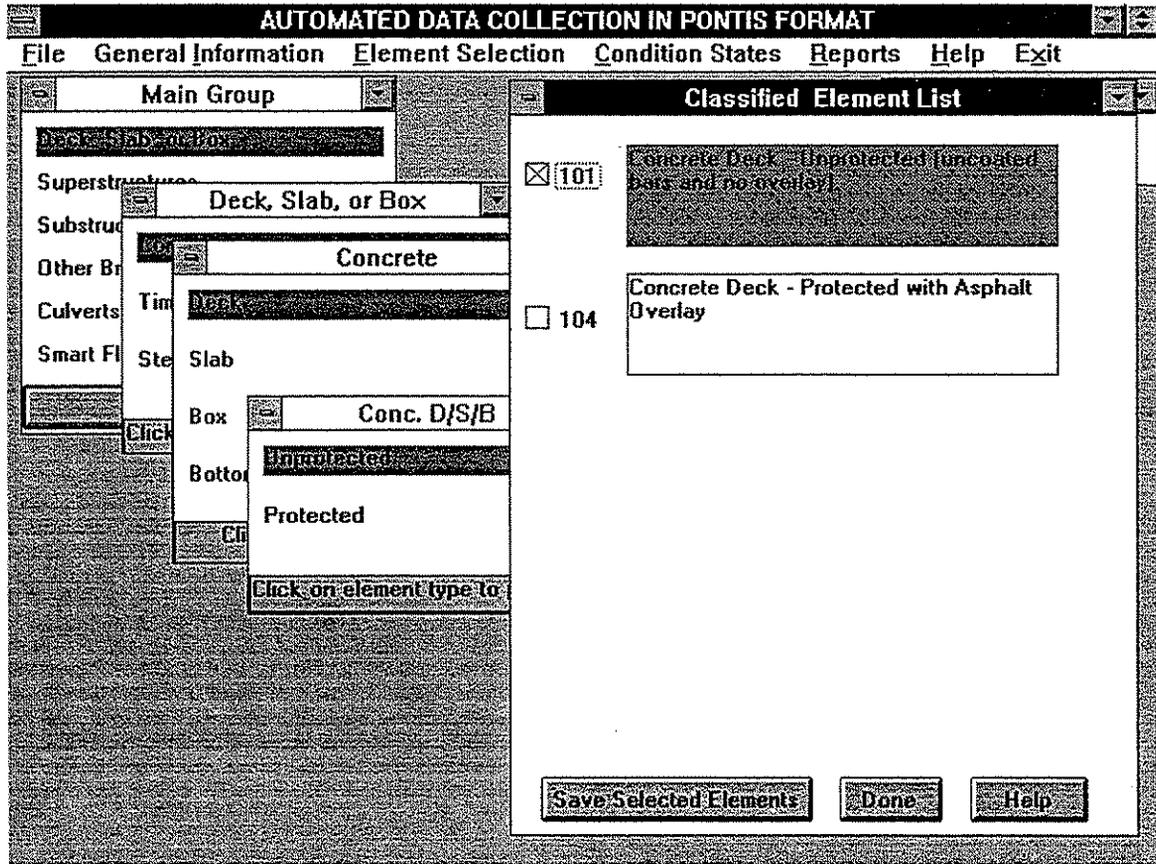


Fig. 5.8 Classified Element List

- Click on *View Selected Elements*. A list of chosen elements appears as shown in Fig. 5.9. To add or delete a chosen element, the user needs to follow the procedure explained in Sec. 5.3.3.1. or Sec. 5.3.3.2.
- Click on *Done* to exit this window.

As previously mentioned, the part of inspection explained in the previous sections can be accomplished in the office and the data saved in a temporary file as explained in Sec. 5.3.2.3. In the field, the user can resume the inspection by reading the data from the temporary file (see Sec. 5.3.2.2.) and proceed to complete the inspection as explained in the following sections.

5.3.4. Condition State Data³

5.3.4.1. Input for General Elements⁴

As previously explained, the Pontis program rates the condition of a bridge element using a set of three to five condition states. These states define and describe the present condition of an element and the required maintenance action to improve this condition. The steps to define the condition states are listed below:

- Click on *Condition States* in the top level menu bar. This will open the two windows illustrated in Fig. 5.10. The *E No.* window appearing on the bottom right of the screen lists the selected elements. The condition state input window appearing on the left side

³ Click on *Calculator* under *Help* in the top level menu bar to get the *Windows* calculator on screen to assist in data entry if needed.

⁴ For inspection of bridges span by span, the user/inspector can perform the inspection for one span at a time then return to the element number again and add data for the next span by entering the additional data in the input cells and clicking on *Ok*.

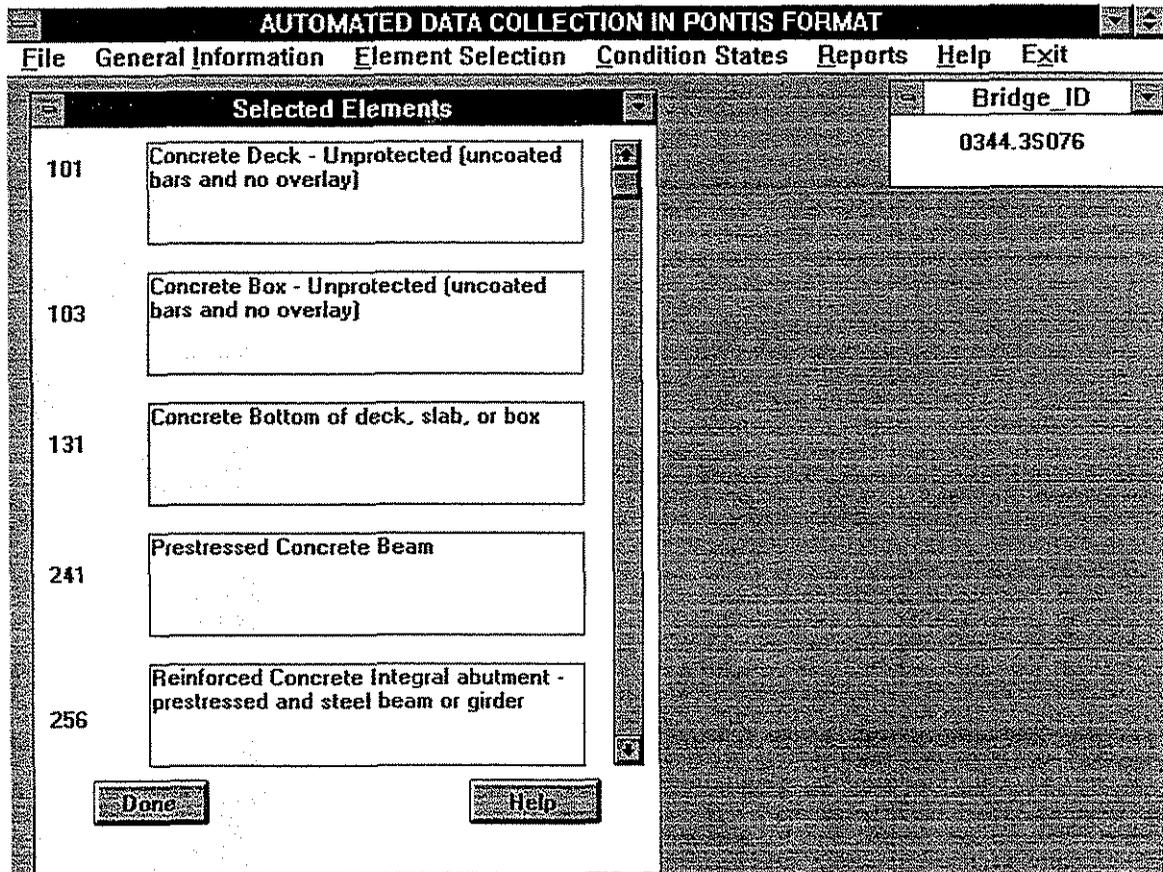


Fig. 5.9 View Selected Elements

AUTOMATED DATA COLLECTION IN PONTIS FORMAT

File **General Information** **Element Selection** **Condition States** **Reports** **Help** **Exit**

Condition State Data for Element #101

Element Number

Concrete Deck - Unprotected (uncoated bars and no overlay) DATA SAVED

Data Input in:

Percentage Units

Absolute Quantity Square Feet

Quantities

Condition State #	New	Total %
<input type="checkbox"/> 1	<input type="text" value="100"/>	<input type="text" value="100.00"/>
<input type="checkbox"/> 2	<input type="text" value=""/>	<input type="text" value="0.00"/>
<input type="checkbox"/> 3	<input type="text" value=""/>	<input type="text" value="0.00"/>
<input type="checkbox"/> 4	<input type="text" value=""/>	<input type="text" value="0.00"/>
<input type="checkbox"/> 5	<input type="text" value=""/>	<input type="text" value="0.00"/>

Condition State 2 Description

Repaired areas and/or spalls/delaminations exist in the deck surface. The combined distress area is 2% or less of the deck area. If deck has any spalls with exposed reinforcing bars showing no evidence of corrosion.

Feasible Actions
1) DN

Bridge_ID

E No.

Selected Element #'s

Fig. 5.10 Condition State Data Input for an Element

- of the screen is used to define the condition state data for each of the selected elements.
- Click on the element number in the *E No.* window to select the element for which the inspection data are to be provided. The element name, element number, and the units of measurement associated with the selected element will be displayed in the condition state input window. For example, square feet units are used to measure the deterioration in the concrete deck elements. Any previously defined data for the element will also be displayed. The user may click on *Erase* to delete the previously defined data.
 - Enter the environmental condition number in the box to the right of the *Env. Con.* button. The default environmental condition is 1. To list definitions for the environmental conditions, click on the *Env. Con.* button. This will open the window displayed in Fig. 5.11. Clicking on one of the four states will give a detailed explanation of these environmental conditions.
 - Click on *Help* in the condition state data window displays window as shown in Fig. 5.12.
 - Select data entry type for the condition states. The default mode is percentage; however, the user can change this by clicking on *Absolute Quantity*. If resuming an inspection, the previously defined data-entering mode, i.e., percentage or absolute quantity, will be shown. The user must use the same mode when adding new inspection data for this particular element.
 - In some situations such as when inspecting a continuous span bridge the user may desire to define the quantities in the different condition states for each individual span. In this case, an inspector needs to enter the total measure quantity per span in the box labeled *New Quantity*.

AUTOMATED DATA COLLECTION IN PONTIS FORMAT

File General Information Element Selection Condition States Reports Help Exit

Condition State Data for Element #101

Element Number Env. Con.

Concrete Deck - Unprotected (uncoated bars and no overlay)

Bridge ID #

Environmental Condition

Data Input in :
 Percentage
 Absolute Qua

Condition State # New

1	<input type="text"/>
2	<input type="text"/>
3	<input type="text"/>
4	<input type="text"/>
5	<input type="text"/>

1) Benign
2) Low
3) Moderate
4) Severe

Click on the Environment Condition number on the left for the definitions.

E No.

Selected Element #'s

101
103
131
241
256
314
321
336

Fig. 5.11 Environmental Condition Input

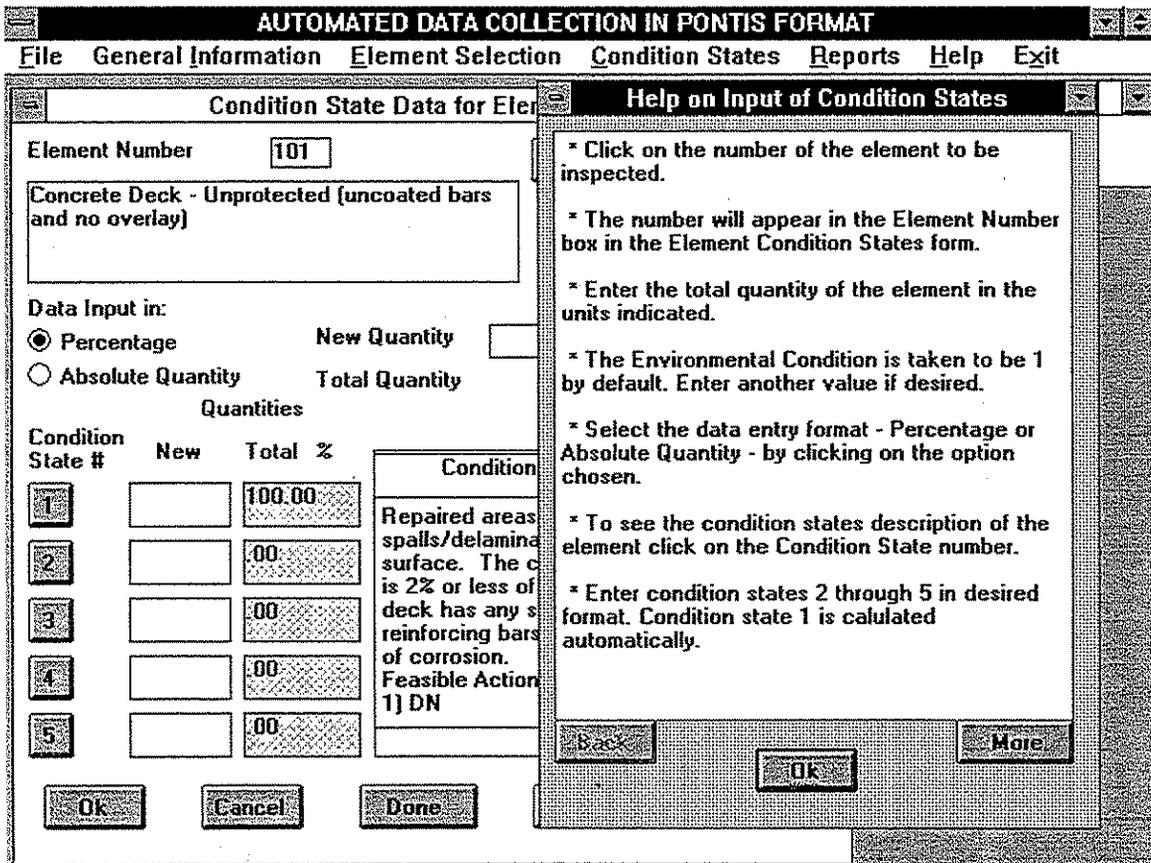


Fig. 5.12 Help for Input of Condition States

On the other hand, if the user desires to provide the condition states for the entire element at one stage, the total measure quantity must be provided in the box labeled *New Quantity*.

- The user may click on any one of the numbers that appear on the left side in the condition state input window to display the definition of the respective condition state. This will provide the user with an explanation of the condition states associated with the element being inspected.
- Enter the condition state data for condition states 2 through 5. The program calculates condition number 1 by subtracting the sum of condition states 2 through 5 from the total quantity. Use the tab key or the mouse locator to move from one box to another. If the entire element exists in condition state 1, the user need not enter any values for any condition state and may proceed as follows.
- Click on *Ok* when finished defining the required input for a particular element. If the entry of condition state is not consistent with the total quantity, an error message is generated.
- To delete the defined data for the condition states for an element, the user needs to click on the *Erase* button. The program allows the user to delete the newly defined input or the entire data for the element.
- To modify a previously defined input the user needs to enter only the difference required to correct the data in the input cells labelled *New* and then click on *Ok*. The modified values will appear on the screen under the label *Total Percentage* or *Total Absolute Quantity*, whichever the user is using.

- To define the condition states for another span, click on the element number and repeat the steps listed above. The program will add the measure quantity provided for each condition state and display the total.

5.3.4.2. Input for Smart Flags

As mentioned in Chapter 4, certain data such as scour and fatigue cannot be categorized as elements but rather were defined by the Pontis Technical Advisory Committee as smart flags. These features of deterioration must be accounted for when allocation of funds occurs. Smart flags cannot be quantified either using different measure quantities in different condition states or using the environmental condition state.

When the user clicks on the element number in the *E No.* window, which corresponds to a smart flag, the warning message shown in Fig. 5.13 will be displayed. This window can be closed by clicking on the *Cancel* button. Click on *Ok* if a smart flag exists in condition state one. Otherwise input 100 in the box corresponding to the existing smart flag condition state.

5.3.4.3. Saving Inspection Data For Future Use

At this stage of the ADC program, the user must save all the inspection data in a temporary file. This file can be used in the future to perform an inspection for this particular bridge. To accomplish this step, click on *Done* in the condition state input window and respond to the questions appearing on the screen. If the user selects to save the data, the window seen in Fig. 5.4 will be displayed. Refer to Sec. 5.3.2.3 for procedure to save the inspection data to a file.

AUTOMATED DATA COLLECTION IN PONTIS FORMAT

File **General Information** **Element Selection** **Condition States** **Reports** **Help** **Exit**

Condition State Data for Element #336

Element Number:

Smart Flag, Steel - connections

Data Input in:

Percentage Units

Each Each

Condition State #	No.
1	<input type="checkbox"/>
2	<input type="checkbox"/>
3	<input type="checkbox"/>
4	<input type="checkbox"/>
5	<input type="checkbox"/>

Smart Flag

Warning:

This Element is a Smart Flag.

Total Quantity and Environmental Condition are not defined for the element.

The input is in Percentage.

The entire element exists in one condition state.

Input 100% as condition state for one state only.

Bridge_ID

0344.35076

E No.

Selected Element #'s

101

103

131

241

256

314

321

336

Fig. 5.13 Condition State Data Input for Smart Flags

5.3.5. File Creation and Output from ADC Program

After an inspection of a bridge is successfully completed, the user needs to save the data in three different files including the temporary file mentioned in the previous sections. The other two files are an Intermediate Pontis file and an Inspection Report. The procedure to create these two files and their use is explained in the following sections.

5.3.5.1. Intermediate Pontis File⁵

The final goal for a user is to create files containing bridge inspection data for a group of bridges to be used in the Pontis BMS program. For this purpose, an intermediate Pontis file for each bridge has to be created by the ADC program. This file will be used as input for the second program, PDFC, which is used to prepare Pontis input files. The user needs to follow the steps listed below to create this intermediate Pontis file.

- Click on *File* in the top level menu bar.
- Click on *Intermediate Pontis File* from the drop-down list. This will open the window shown in Fig. 5.14. The user can then proceed to select the drive and/or the directory (or subdirectory) where the file has to be saved, as explained in Appendix A. If the directory or subdirectory having the residency number of the bridge does not exist, the ADC program will create one on the chosen drive or directory.
- Click on *Output File for PDFC* to save the inspection data in a file designated by the bridge's FHWA number, with extension pnt, in the directory or subdirectory selected in the step above.

⁵ If the inspection is incomplete the user can create the temporary file and Inspection Report but not the Intermediate Pontis file.

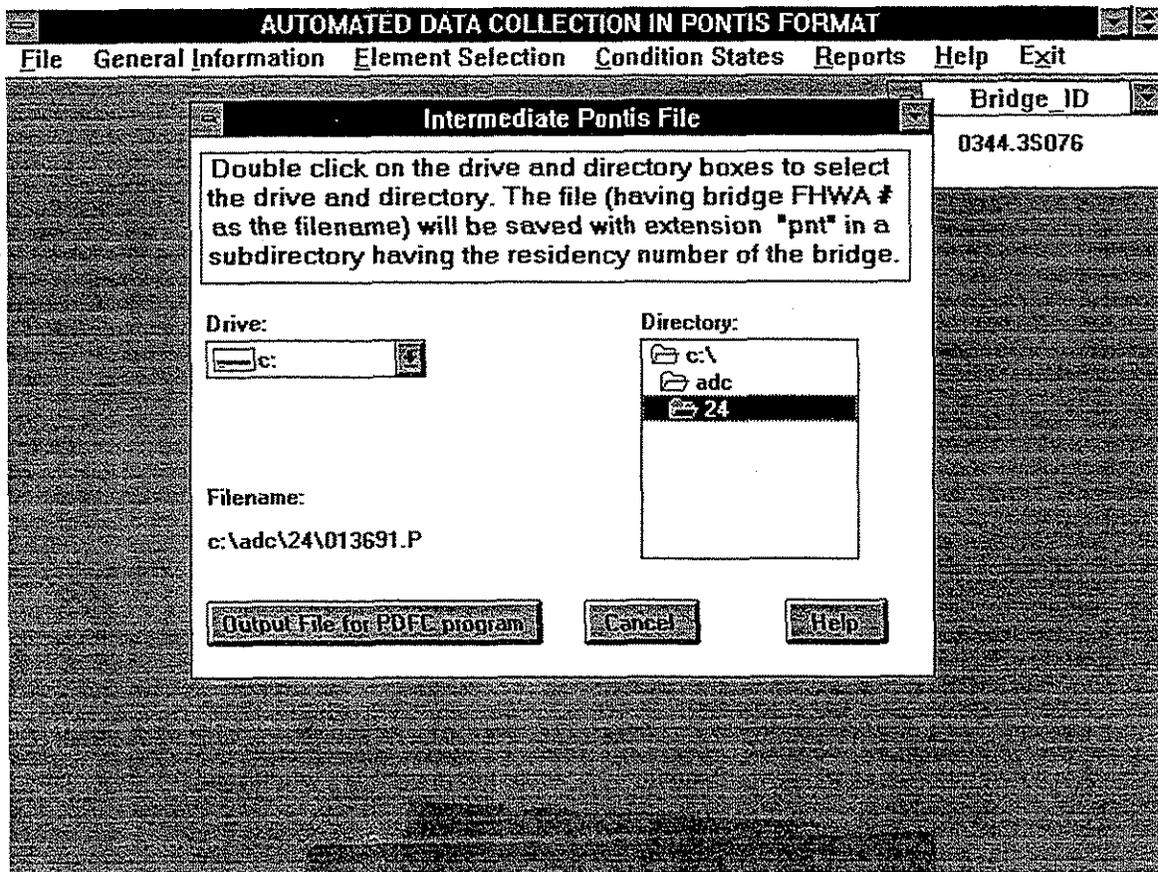


Fig. 5.14 Creating Intermediate Pontis File

5.3.5.2. Inspection Report⁶

After an inspection is completed, the user can prepare an inspection report for a bridge in a form similar to the Element Data collection form used by the IADOT. The file containing the inspection report has the default extension of txt.

Prior to preparing an inspection report, the user must save all provided inspection data in a temporary file. If this step was not successfully completed, a message reminding the user to save the data will appear. The user needs to save the data as explained in Sec. 5.3.2.3 and then proceed.

The procedure to create an inspection report is explained below:

- Click on *Reports* in the top level menu bar.
- Click on *Inspection Report*. This will open the window shown in Fig. 5.15. The user can then proceed to select the drive and/or the directory (or subdirectory) where the file has to be saved, as explained in Appendix A. If the directory or subdirectory having the residency number of the bridge does not exist, the ADC program will create one on the chosen drive or directory.
- Click on *Prepare Inspection Report* in the window shown in Fig. 5.15. The inspection report will be created in a file designated by the bridge's FHWA number, with extension txt, in the directory or subdirectory selected in the step above.

⁶ This file is created for bookkeeping purposes and is not used in the program.

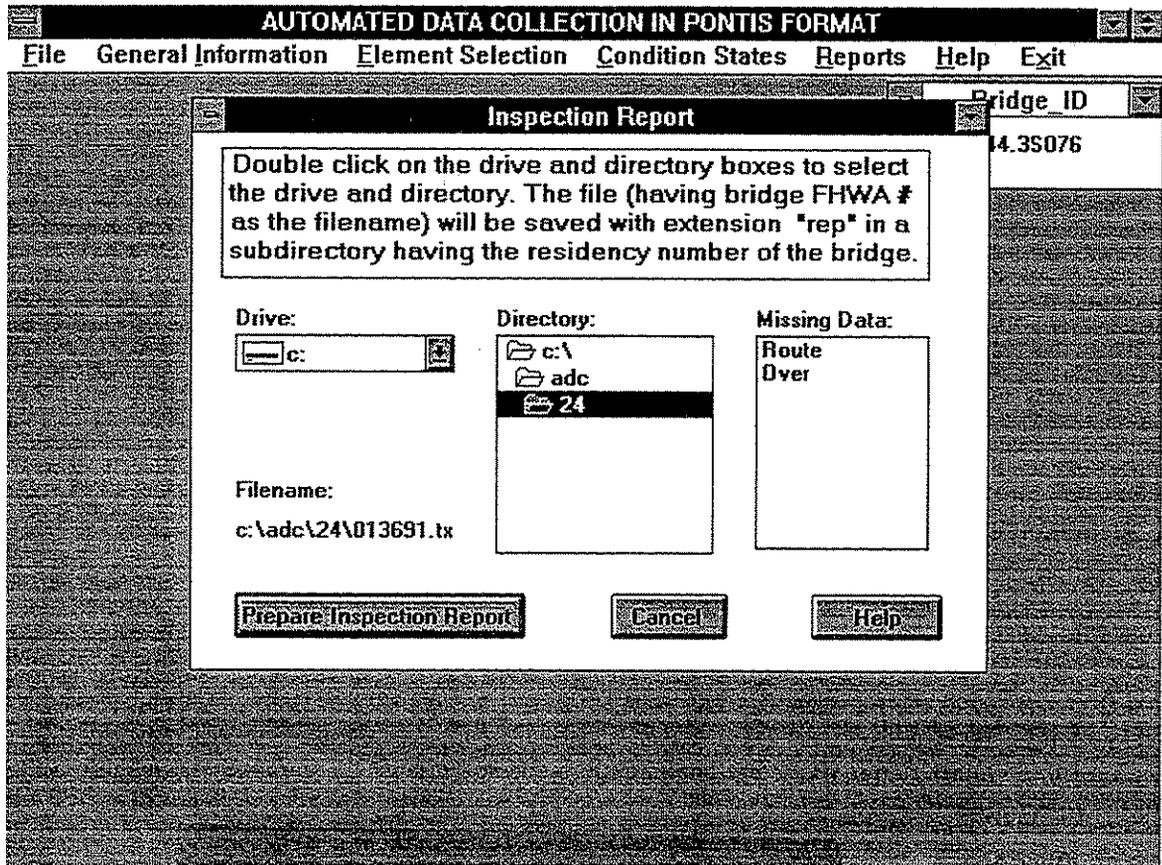


Fig. 5.15 Preparing an Inspection Report

If any of the bridge-level data was not provided by the user, a list of the missing information will be displayed on the window as shown in Fig. 5.15. Also, a warning will appear if element inspection data are incomplete. In this case the user needs to input the missing information and proceed with preparing the inspection report.⁷

5.3.6. Viewing and Printing Reports

To view or print the inspection reports the user needs to follow the steps listed below:

- Click on *Reports* in the top level menu bar.
- Click on *View Reports*. The Notepad application of Windows shown in Fig. 5.16 will be displayed on the screen.

5.3.6.1. Viewing and Editing Inspection Reports

In the Notepad application click on *File* and follow the steps summarized in Appendix B to retrieve the report to be viewed. A sample inspection report is shown in Appendix C. The user may edit and add comments to the report. Any changes must be saved as explained in Appendix B.

5.3.6.2. Printing Inspection Reports

- To print the report files, click on *Reports* in the top level menu bar.
- Click on *View Reports* and follow the steps summarized in Sec. 5.3.6.1 to view the selected inspection report. The desired file can then be printed as explained in Appendix B.

⁷ The user may create an inspection report with data missing.

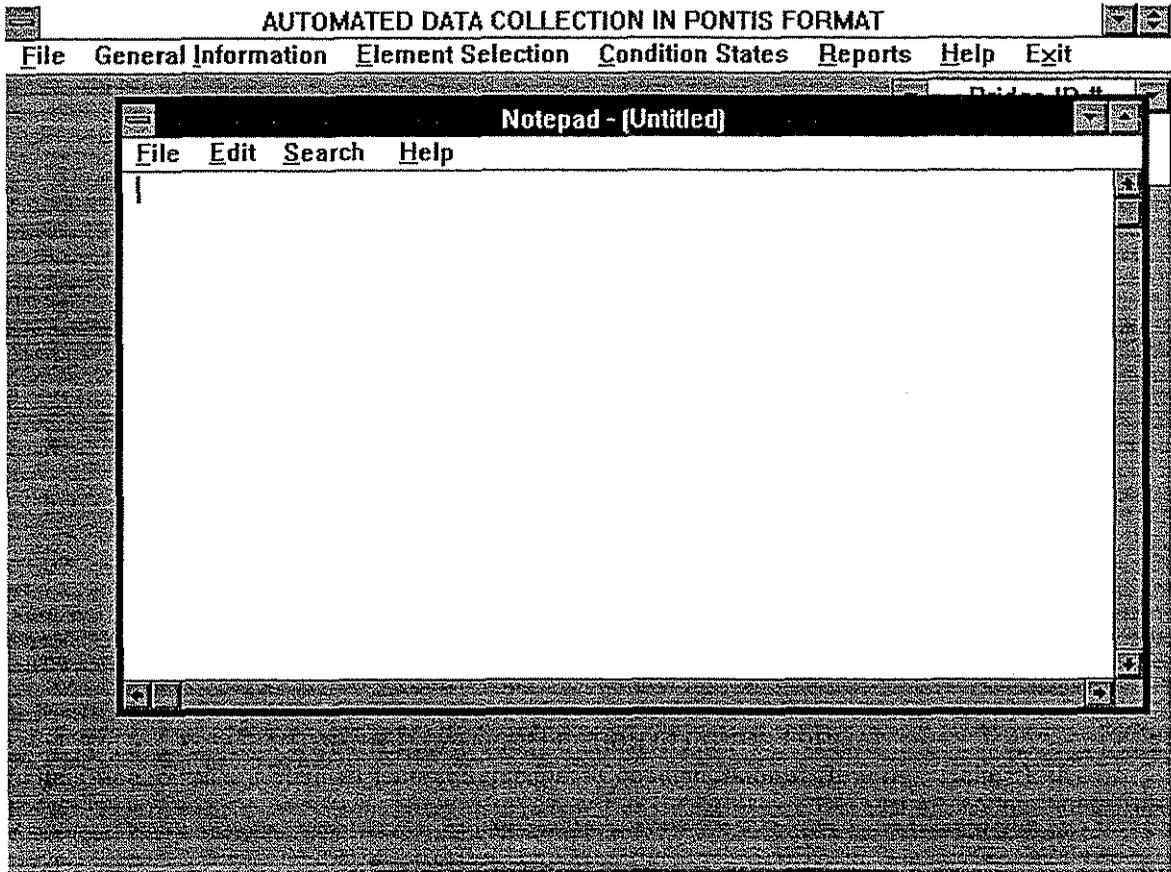


Fig. 5.16 Notepad Application to View Inspection Reports

5.3.7. Inspection of a Different Bridge

A user who wishes to begin a new inspection or resume an inspection before exiting the ADC program needs to click on *New Inspection* or *Resume an Inspection* under *File* option in the top menu bar and follow the steps listed above.

5.3.8. Exiting the ADC Program

Click on *Exit* in the top level menu to exit the ADC program. This command will close all files, end the procedure for executing the ADC program, and return the user to the Windows program manager.

5.4. Pontis Data File Creation (PDFC) Program

The Pontis program, as mentioned earlier, requires input files consisting of data on several bridges for a network wide optimization. In other words, one needs to combine data of several bridges in one file that will be used by the Pontis BMS program. This step can be accomplished by utilizing the PDFC program which uses the Intermediate Pontis files (*.pnt files) created by the ADC program. Creating these files is to be accomplished in the office by those who desire to utilize the Pontis software.

5.4.1. Getting Started with Pontis Data File Creation

To start the PDFC program, double click on the PDFC icon in the Window Manager (or in the program group in which it is placed). When starting the program PDFC, a welcome window screen will be displayed. To proceed with the program, click the mouse button or any key on the keyboard. This will display the menu screen shown in Fig. 5.17.

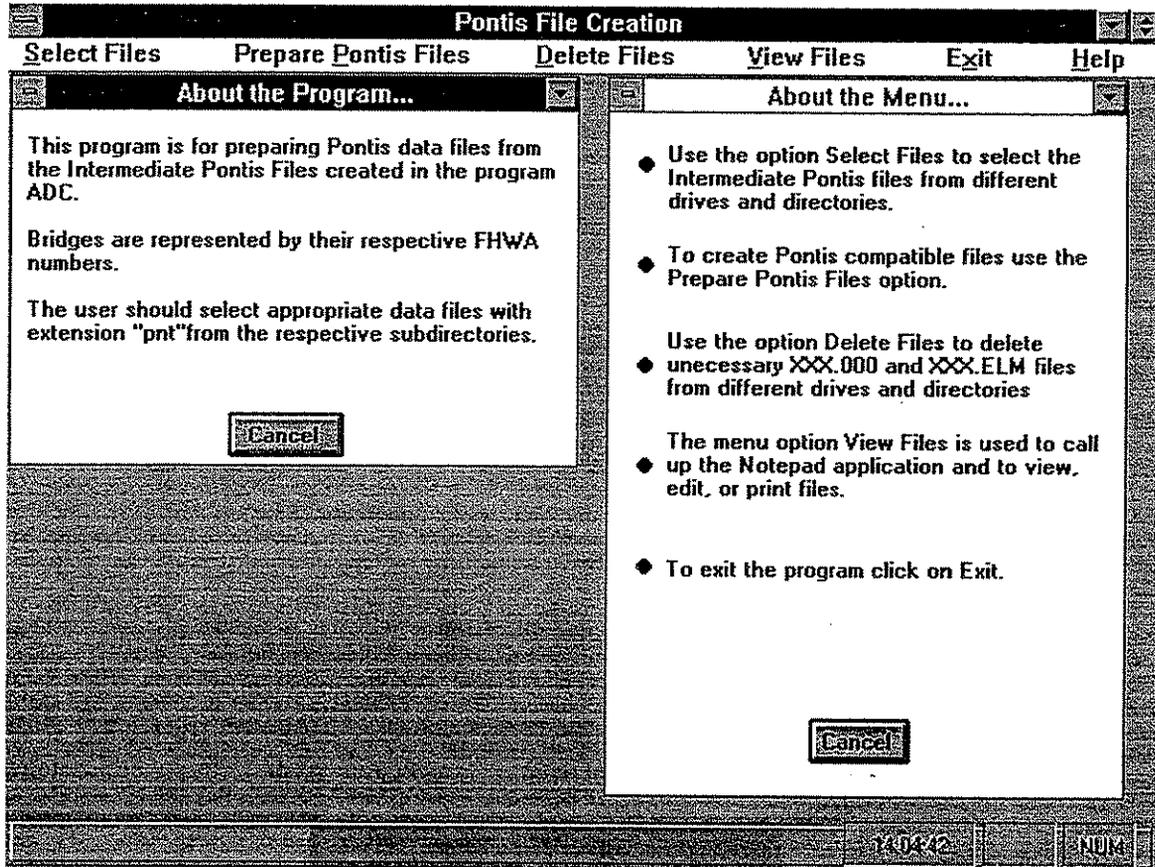


Fig. 5.17 Getting Started with Pontis Data File Creation

The two menus shown in Fig. 5.17 can be displayed at any time during the execution of the PDFC program by clicking on *Help* in the top level menu bar. To obtain information about the steps to be followed to execute the PDFC program, click once on *About the Program* under the *Help* option. For explanation of the different menu options, click on *About the Menu* under the *Help* option. At any stage in the PDFC program the user can obtain help regarding the different windows in the program by clicking on the *Help* button in the particular window that is being used.

5.4.2. Selecting Bridges for the Pontis Data File

The following steps explain the procedure to select the files containing inspection data for the bridges to be used in the Pontis BMS.

- Click on *Select Files*. This will open the windows shown in Fig. 5.18.
- As explained in Appendix A, select the drive, directory, and/or subdirectory containing the file to be included in Pontis data file. The user can select files from different drives and directories.
- Use one of the following two alternatives to select the bridge data files to be included in one Pontis data file: 1) Double click on the file to be selected from the File List box shown in Fig. 5.18 or 2) Click once on the file to be selected from the File List box shown in Fig. 5.18 and then click on *Add Bridges*.

Note: The program allows the user to select up to fifty files at a time. All selected bridge data files will be listed in the box labelled *Selected Files* as shown in Fig. 5.18. However, the user can create Pontis data files for more than fifty bridges as explained in Sec. 5.4.3.2.

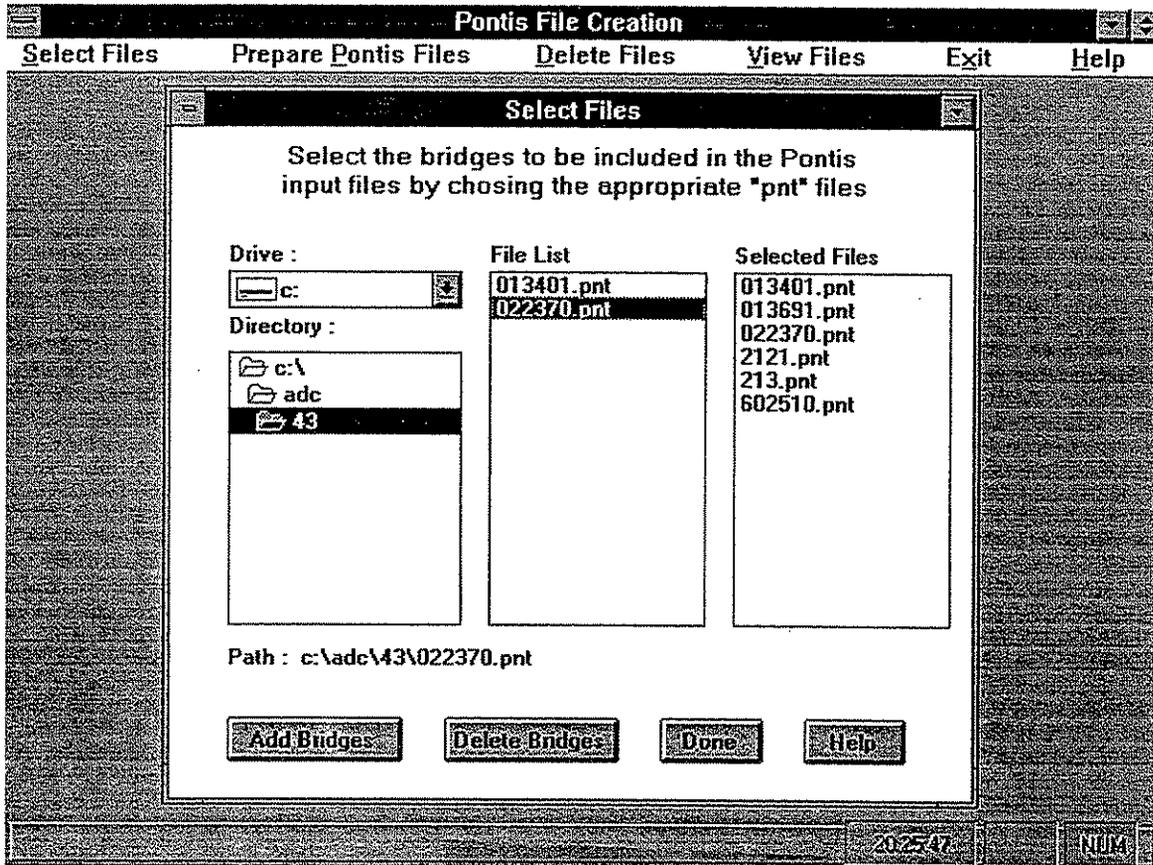


Fig. 5.18 Selecting Bridges

- To delete a bridge from the selected list, click on that particular file in the *Selected Files* list and click on *Delete Bridges* or click twice on the filename in the *Selected File* list.
- Click on *Done* when finished selecting all bridge data files.

5.4.3. Creating PONTIS Data Files

Two types of data files are required by the Pontis software, XXX.000, and XXX.ELM, where XXX is the file name. File XXX.000 contains the bridge_ID and the date of inspection of the bridge, and the file XXX.ELM has the element inspection data. The procedure for creating these files is identical and can be accomplished as follows:

- Click on *Prepare Pontis Files* in the top level menu bar.
- Click on *XXX.000 File* or click *XXX.ELM File*, whichever the user desires to create.

Depending on the user's selection, either the screen shown in Fig. 5.19 or the one in Fig. 5.20 will be displayed. The *.pnt files, selected in Sec. 5.4.2, are shown in the window indicating the selected bridges. The user may create new Pontis data files or append data of the selected bridges to existing Pontis data files. The steps to accomplish this task are explained in the following sections.

5.4.3.1. To create a new Pontis file

As mentioned earlier the user may first create either the XXX.000 or the XXX.ELM file. In the appropriate window (as shown in Fig. 5.19 or Fig. 5.20) enter the name (XXX) for the Pontis data file in the box labeled *File Name* and click on *Ok*. The user need not specify the extension for the file names. The path of the file, namely the drive, directory, and subdirectory, is shown. Repeat the same procedure to create the other Pontis file.

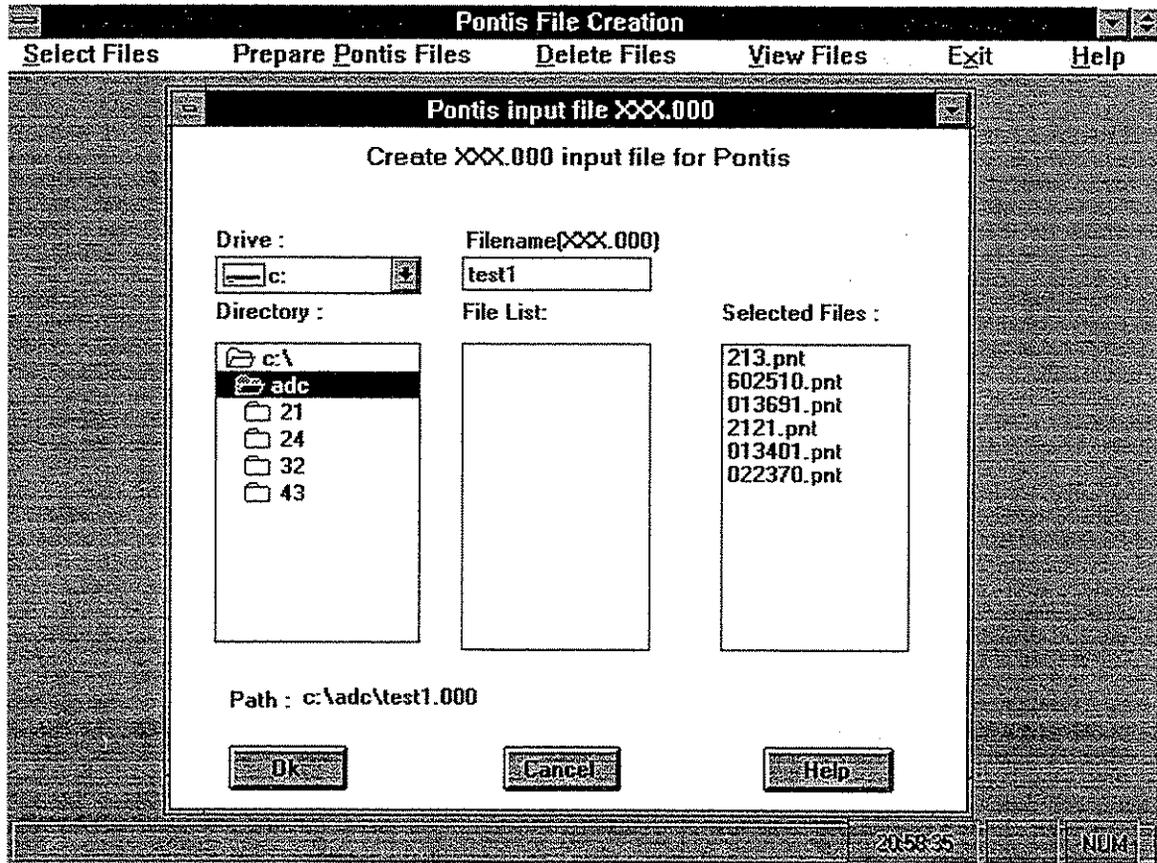


Fig. 5.19 Creating a XXX.000 Pontis Data File

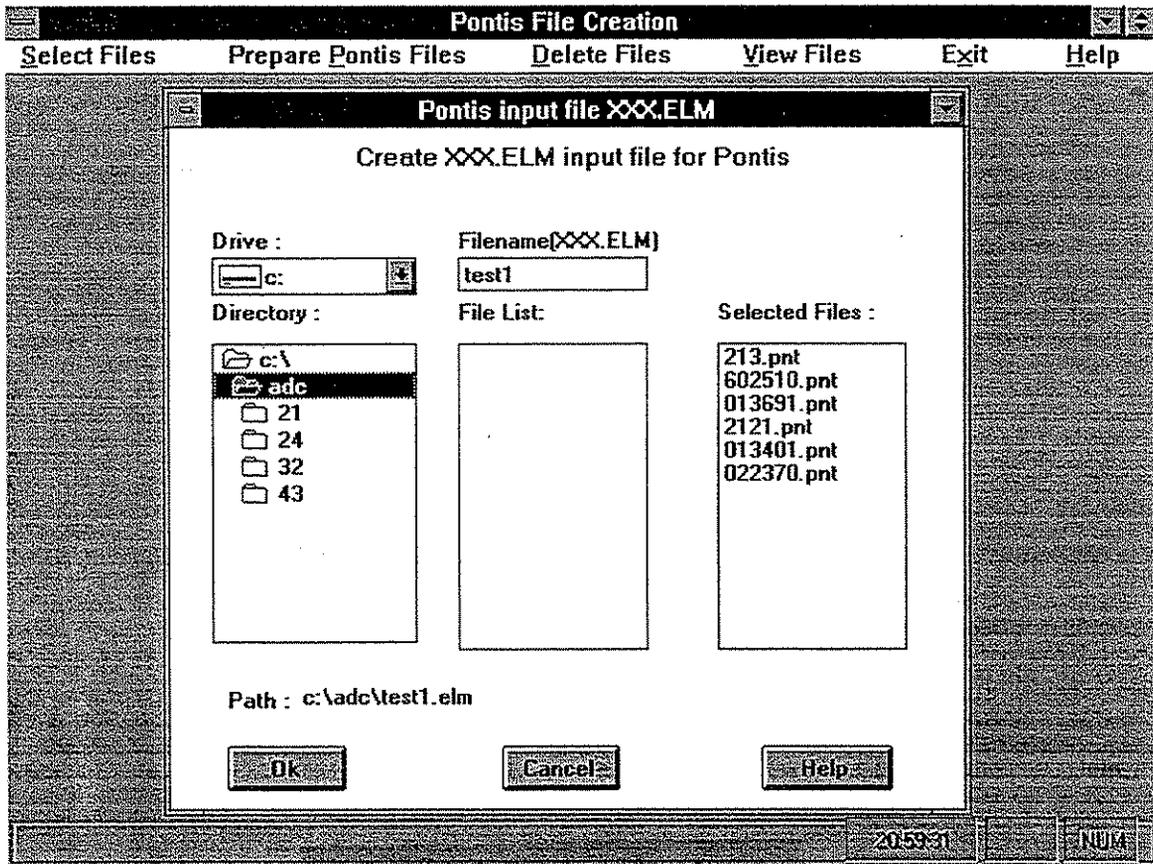


Fig. 5.20 Creating an XXX.ELM Pontis Data File

5.4.3.2. To append data to an existing Pontis file

If the user wishes to create a data file for the Pontis program with more than fifty bridges, the user should first create a file (XXX.000 and XXX.ELM) with fifty bridges and exit the program. The user should then restart the program and select additional files as explained in Sec. 5.4.2. These additional data files can then be appended to the previously created XXX.000 and XXX.ELM files as explained below:

- Click on the existing Pontis file (XXX.000 or XXX.ELM) in the file list box as seen in Fig. 5.19 or Fig. 5.20.
- Click on *Ok*. The bridge data from the selected bridges will be appended to this file at the end.

If the data for one of the selected bridges exist in the previously created XXX file, a message indicating that there is a duplicate data comes up on the screen. In this case the user must exit the window, delete the particular bridge data file from the selections, and repeat the procedure listed above. The user can view the data file to check which bridge data exist in the file. This procedure is explained in the next section.

Note: Once the XXX.000 and XXX.ELM files are created the *.pnt files can be deleted. However, to include the inspection data for these bridges again or to add other bridge data combinations, for Pontis optimization process, these files will need to be re-created using the ADC program.

5.4.4. To View or Edit a Pontis Data File

To view or modify an existing Pontis data file, the user needs to click on *View Files*. The Notepad application of Windows will be displayed as seen in Fig. 5.16. The user can open a file, and if required, edit it as explained in Appendix B. Appendix C contains a set of sample Pontis data files.

5.4.5. To Delete Files

Files with extension 000 and ELM are not needed once they are input in the Pontis software. These files can be deleted using the *Delete Files* option in the top level menu bar in PDFC program.

To delete the XXX.000 and XXX.ELM files, click on *Delete Files* in the top level menu. The window illustrated in Fig. 5.21 will be displayed and the user needs to select the appropriate file for deleting. Deleting the XXX.000 file implies deleting the XXX.ELM file of the same filename (if present) from the same directory and vice-versa.

5.4.6. To Exit the Program

To exit the PDFC program click on *Exit* in the top level menu bar.

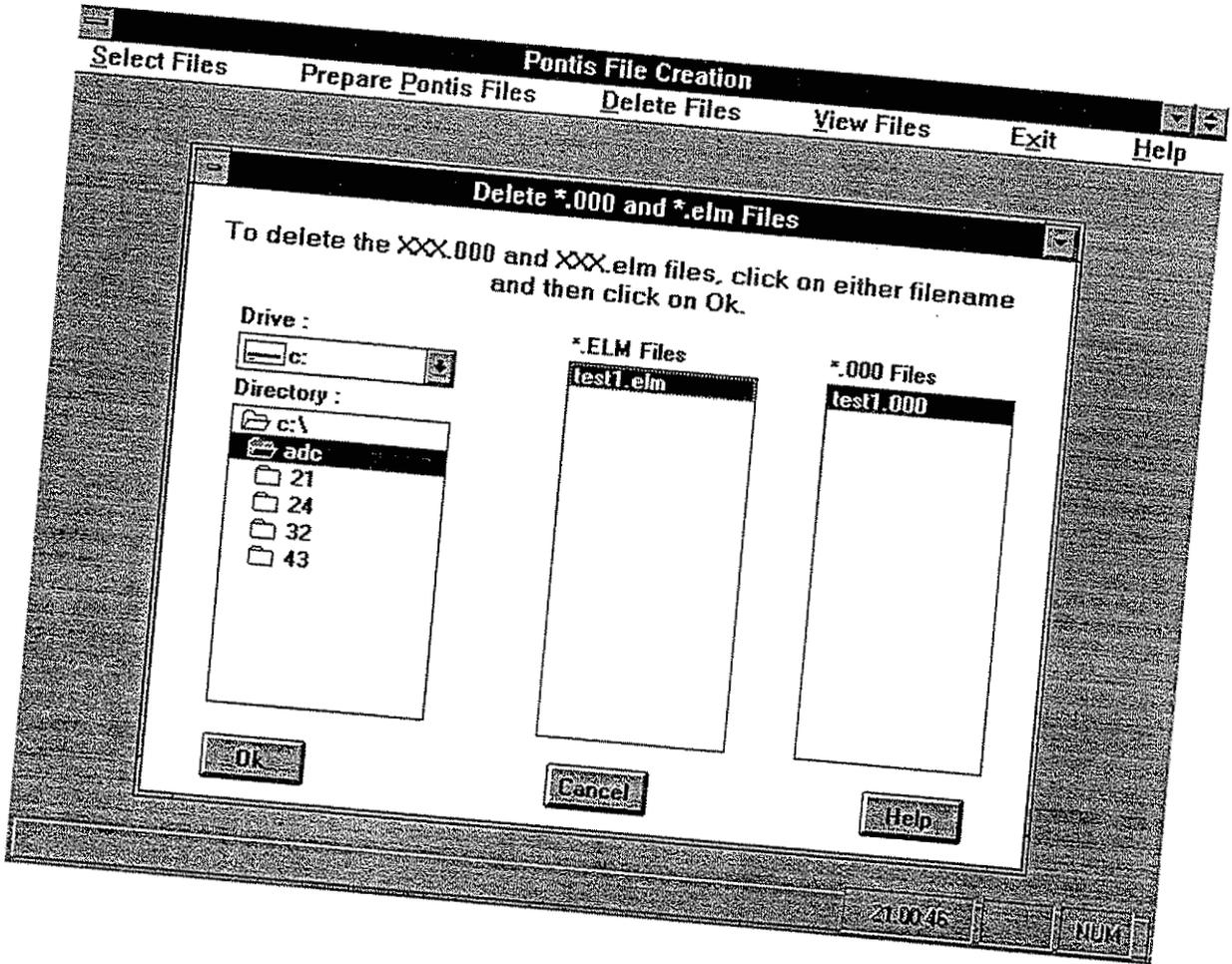


Fig. 5.21 Delete Files

6. SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

6.1. Summary

Because of the importance of bridges in the transportation network and the budgetary constraints on maintenance, repair, and rehabilitation activities, the need for a comprehensive Bridge Management System exists. As a result, the U.S. Department of Transportation has developed legislation that requires states to implement a Bridge Management System by October 1998 in order to be eligible for federal funds. The Pontis software has been selected by the Iowa DOT as a bridge management system tool for the bridges in the state of Iowa.

The Pontis software requires bridge inspection data for multiple bridges so that maintenance activities can be selected for each bridge. To manually collect the data regarding the condition states and environmental condition of each element of a bridge for every bridge to be included in the Pontis program would be a highly time consuming job. The objective of this study was to develop an automated-computerized methodology for collecting bridge inspection data and preparing input files for the Pontis software.

An extensive literature review was conducted to find out the current practices in bridge inspection by contacting various state DOTs. Based on this study and upon the recommendations received from the Iowa DOT's maintenance division, two interactive computer programs were developed for bridge inspection. Various application software packages were considered when developing these programs. Microsoft Visual Basic Professional Edition 3.0 was used as the tool for the program development.

The Pontis BMS software was studied to get acquainted with the Pontis inspection method. The different modules and components of the Pontis BMS were summarized. The Pontis software

classifies a bridge into various elements. Different parts of the element may exist in one through five condition states. An environmental condition state, one through four, is also defined for every element. Certain features such as rust, fatigue, and scour were introduced in the Pontis BMS using what is referred to as smart flags.

The Iowa DOT has identified the possible elements present in the bridges across the state of Iowa. A different numbering scheme than that used in the Pontis program was developed, and definitions for condition states and feasible actions for these elements were defined. These elements have a certain relationship with the Pontis-defined elements.

Since the Pontis software requires bridge level data as well as element level data, a program was written to download the bridge level data from the Iowa DOT inventory. This information included the bridge ID, FHWA number, residency number of the bridge, and so on.

Two user-friendly programs referred to as ADC and PDFC, with on-line help menus, were developed for the task mentioned above. The ADC program is used to carry out the bridge inspection in the field, and the PDFC program creates Pontis data files. The user manual for the developed program explains in detail the steps to be taken while performing the inspection. To execute these programs the user needs to have basic computer knowledge. The Iowa DOT numbering system was used in the ADC program and was then converted to the Pontis numbering system prior to preparing the inspection data file for the Pontis program.

The ADC program has an on-line help menu that provides a description for each condition state of the Iowa DOT-defined elements. Also, the program indicates the units of measurement for the elements and allows the user to input percentages or absolute quantities. The ADC program can also print an inspection report similar to that currently used by the Iowa DOT. The PDFC program

allows the user to select different combinations of bridges to be included in the Pontis BMS optimization routines.

6.2. Conclusions

Automating the bridge inspection procedure will improve the process of project management. The programs developed have been tested at the Iowa DOT by maintenance division personnel. Many changes were incorporated in the program as it was being developed based on the recommendations and suggestions of the Iowa DOT maintenance engineers.

Some of the benefits of using the automated procedure are listed below:

1. Detailed field inspection required in the Pontis format is carried out.
2. Inspection reports are efficiently produced in a standard format. The developed software allows the user to add any comments related to the inspection.
3. All element inspection data can be stored on computer disks, thus eliminating the need for larger storage areas.
4. A considerable amount of time is saved in input of data in the Pontis software.
5. Inspection data and reports can be transferred electronically between offices within or across the state.
6. The developed software eliminates the need to have a Pontis manual during a bridge inspection.
7. Storing the inspection data utilizing computer will simplify retrieving any bridge inspection data.

6.3. Recommendations

The software developed in this project is just a first stage of automation of bridge inspection and the bookkeeping associated with it. The procedure can be further developed and simplified in the future as the technology advances. On the basis of the work presented herein, it would be logical to consider continuing related research as follows:

1. Pen-Based Application: Using a pen-based computer would eliminate the use of a keyboard. The program described here can be adapted for this technique but would require a pen-based version of Windows software.
2. Voice Recognition: Using this technique, the inspector will be able to "talk" the data into a computer. This would eliminate the use of a keyboard and a pen for input of data.
3. Collecting other bridge inspection data defined in the bridge coding book, sketches of bridge elements, and an automated method for recording agency and user costs are mandatory for a complete and successful Bridge Management System. Computerizing this information will help enormously in maintaining records, eliminate the space required by cabinets and hard copy reports, and facilitate and expedite retrieving data instantaneously.
4. A multimedia interface using CD-ROM and videotapes can be a step toward a complete automation of the inspection-maintenance activities in future.
5. Collecting more detailed inspection utilizing computerized methods will enable the bridge office to conduct more accurate estimates of a bridge's load-carrying capacity.

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- Mr. Roger Walton (Bridge Management Engineer, Iowa Department of Transportation)

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- 7) Jaselskis, E. J., et al, "Field Data Acquisition Technologies For Iowa Transportation Agencies-- Interim Report," IADOT project HR-366, ISU-ERI-Ames-94409, December 1993.
- 8) Fanous, F., Greimann, L.F., and Walton, R., "Bridge Life Study," Report submitted to South Dakota DOT, SD90-04, February, 1993.
- 9) "Pontis CORE Element Task Group Report," Prepared by participating DOTs, June 1993.
- 10) Microsoft Corp., Microsoft Visual Basic, Professional Edition Version 3.0.

Appendix A: FILE OPERATIONS

This appendix gives the user a brief overview of the file operations performed during the use of ADC and PDFC programs. Tasks such as changing a drive or directory and opening, saving, or creating a file are explained in following sections.

A.1. Changing a Drive and Directory

All the files created by the ADC program are named using the bridge's FHWA number and are stored in subdirectories designated by the residency number of each bridge. These subdirectories are created in a directory in the drive selected by the user such as Drive A:, B:, or C:. Once a dialog box for opening or saving a file is opened as shown in Fig. A.1., the procedure to select a drive and a directory is as follows:

- Click on the arrow on the right side of the Drive box in Fig. A.1 and from the drop-down list select the drive, i.e; A:, B: or C:, by clicking on it once.
- The directories in the chosen drive will be displayed in the box labeled Directory (see Fig.A.1). To select a directory double click on it. Each directory may have several subdirectories. A list of subdirectories, if existing, will be shown. To select a subdirectory, double click on it.

This procedure of selecting the drive, directory, and subdirectory is the same in all Windows application software.

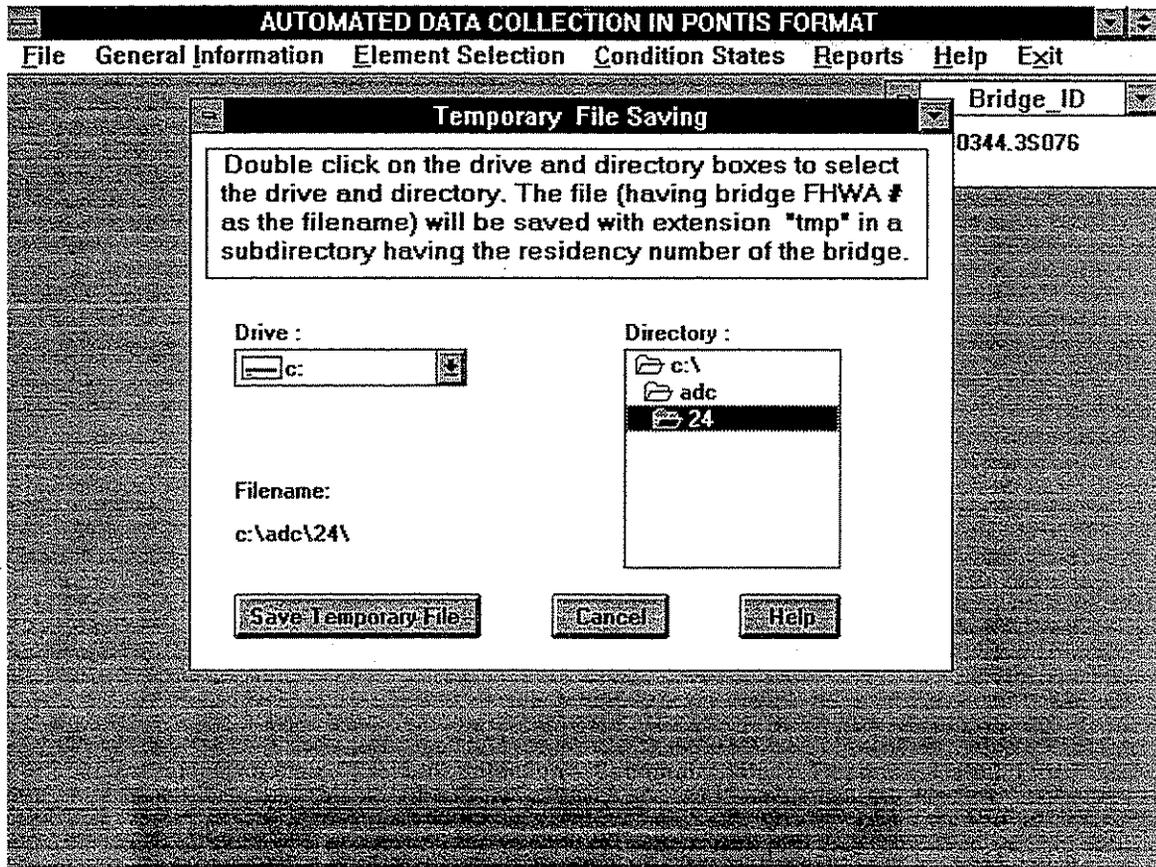


Fig. A.1 Selecting the Drive and Directory

A.2. Selecting a File for Input

This task is performed whenever the user wishes to read in the data of inspection or view, edit, or print an already existing file. After selecting the drive, directory, and subdirectory as explained above, the files present in that subdirectory will be listed in the box labeled *Files*. To select a file click on the desired file and proceed.

A.3. Saving or Creating a File

Before saving the required information in a file, the user needs to select the drive and directory as explained in Sec. A.1. If a directory or subdirectory named by the residency number of the bridge does not exist, the ADC program will create the appropriate directory or subdirectory and then the file will be saved in it.

Appendix B: USING THE NOTEPAD APPLICATION

This appendix briefly describes the Windows Notepad application. The Notepad application can be activated in the ADC or PDFC program by clicking on the *View Files* option. The purpose of this application is to view, edit, and print inspection reports and other files created in the two programs. To know more about any Notepad application command or how to use the Notepad application the user needs to click on *Help* in the top level menu bar and select a particular topic⁸.

B.1. Opening a File

The following is the procedure to open a file in the Notepad application:

- Click on *File* in the top level menu bar.
- Click on *Open*. A dialog box as seen in Fig. B.1 will be displayed. Select the drive and the directory of the file to be opened in the manner explained in Appendix A. All the files in the selected directory having extension txt are listed in a box.
- Select the desired file from the list of files by clicking on it once and click on *Ok* or double click on the file name. This will open a file containing the inspection report as shown in Fig. B.2.
- If a file is not listed, click on *List Files of Type* and select *All Files* from the drop-down list. All the files in the chosen directory will be listed. Proceed to open the desired file as explained above.

⁸Reference to the top level menu bar in this appendix implies the top level menu bar of the Notepad application unless stated otherwise.

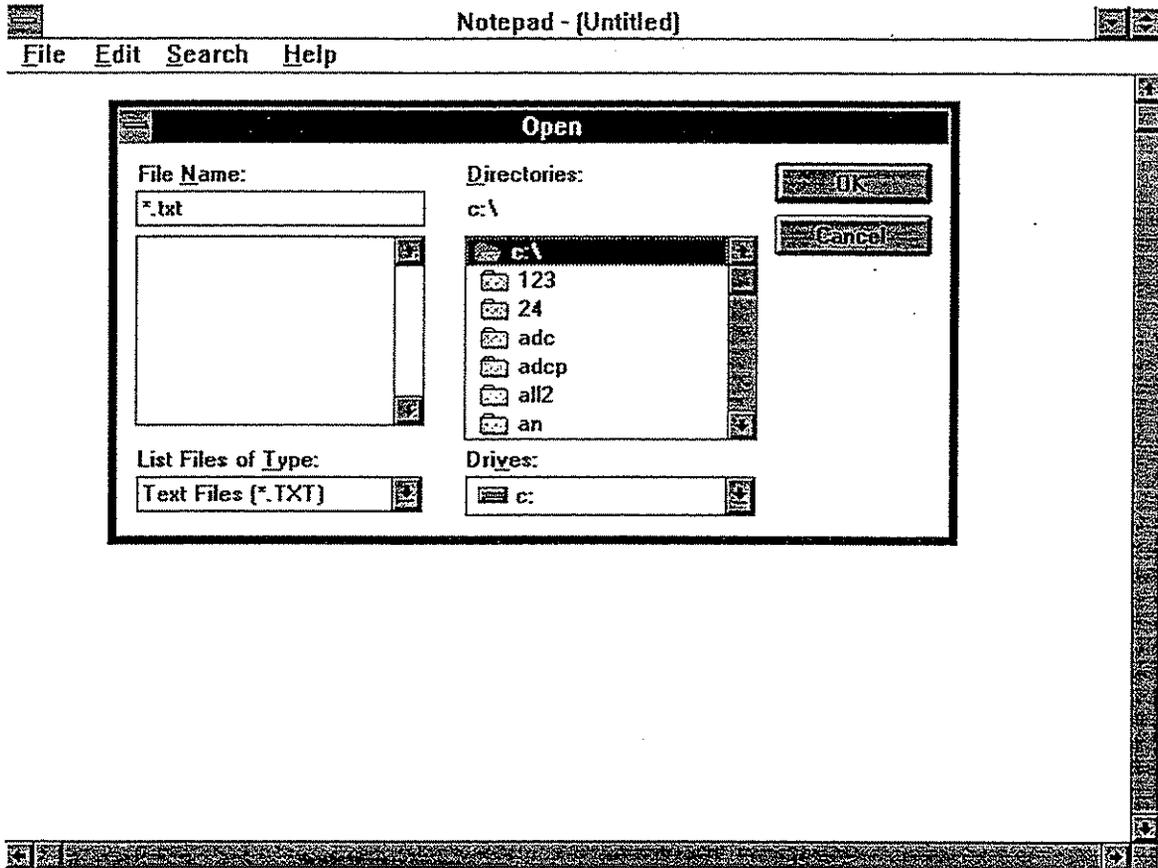


Fig. B.1 Opening a File in Notepad Application

Notepad - 013691.TXT								
File Edit Search Help								
BRIDGE ID: 0344.3S076 Res. No. 24 FHWA No. 013691								
a 66 ft X 44 ft Type : Prestressed Beam								
CARRYING ROUTE Iowa #76 OVER Small Natural Stream								
LOCATED 5.6 miles S of Minnesota State Line								
E.#	El. Name	Ttl. Qt.	1	2	3	4	5	EC
101	Deck-Unprt.	2904.00	100.000.00	0.00	0.00	0.00	0.00	1
103	Box-Unprt.	1000.00	680.0020.00	200.00100.000.00				1
131	Bottom of D,S or B	2904.00	100.000.00	0.00	0.00	0.00	0.00	1
241	P.C.beam	462.00	100.000.00	0.00	0.00	0.00	0.00	1
256	R.C.IntAbut beam	88.00	100.000.00	0.00	0.00	0.00	0.00	1
314	Aluminum railing	143.00	100.000.00	0.00	0.00	0.00	0.00	1
321	Conc. App.Slab	2.00	100.000.00	0.00	0.00	0.00	0.00	1
SMART FLAGS :								
336	Steel Connections	1	0.00	0.00	100.000.00	0.00		

Fig. B.2 File displayed in Notepad Application

B.2. Some Additional Notepad Information

The tasks outlined in the following sections can be performed only after a file has been opened as explained in Sec. B.1. Further information related to the following operations can be obtained utilizing the *Help* command from the top level menu bar.

B.2.1. Editing a File

To edit a file in the Notepad application one needs to

- Use the mouse locator to place the cursor at a desired position where an editing operation is required.
- Use *Edit* from the top level menu bar and make the appropriate selection to use *Undo*, *Cut*, *Copy*, *Paste* and *Delete* options.

B.2.2. Saving a File

Saving a file can be accomplished as follows:

- Click on *File* in the top level menu bar.
- Click on *Save*. If the user wishes to save the file in a different drive or directory or as a different filename click on *Save As*. This will open a dialog box as shown in Fig. B.3. Select the drive and the directory, if different. Enter the desired filename and click on *Ok*.

B.2.3. Searching for a String

The user may wish to search for a particular character or string in the file. To achieve this

- Click on *Search*.

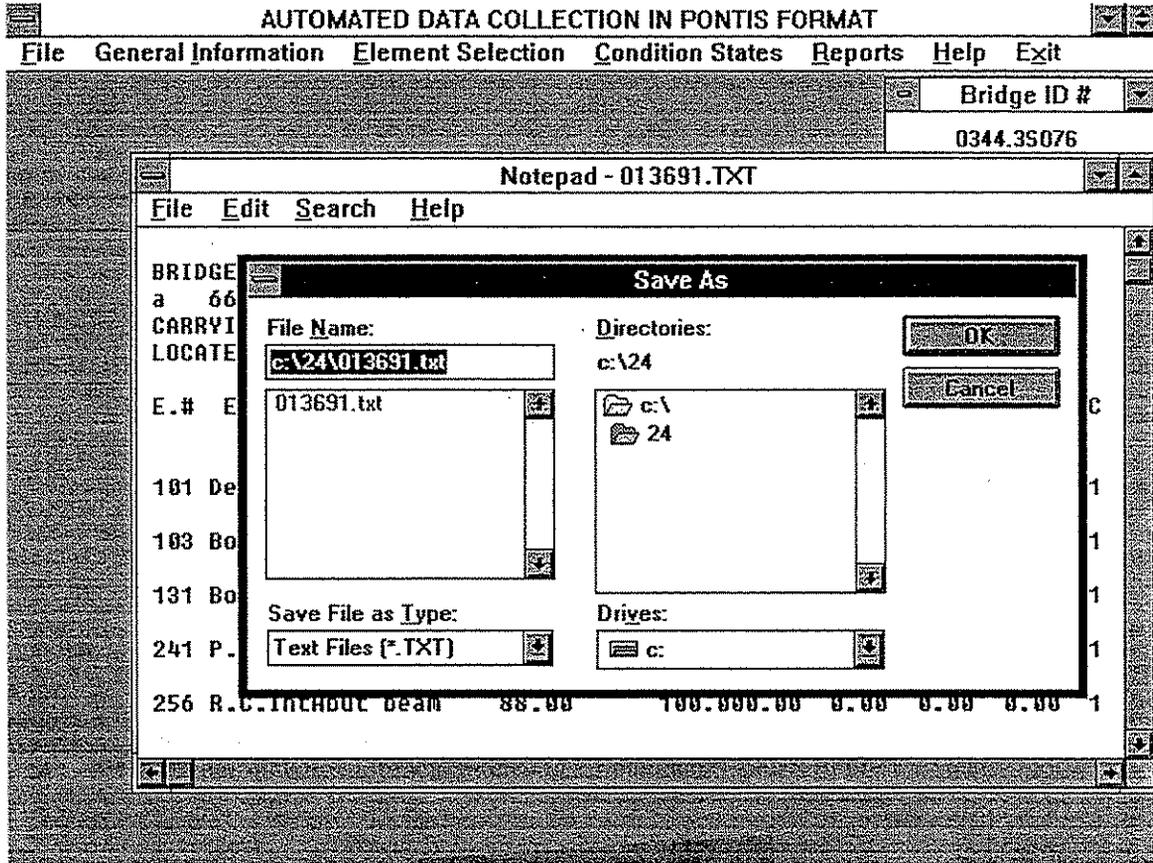


Fig. B.3 Saving a File in Notepad Application

- Click on *Find* from the drop-down list. Enter the text string to search for and click *Ok*. Repeat this procedure or press the F3 key on the keyboard to find the next position of the same string.

B.2.4. Setting up Margins

- Click on *File* in the top level menu bar.
- Click on *Page Setup*. The current page margins will be shown. The user may type new margin specifications if desired.
- Click on *Ok*.

B.2.5. Selecting a Printer

- Click on *File* in the top level menu bar.
- Click on *Print Setup*. Select the printer, the paper size, orientation, etc. and click on *Ok*.

B.2.6. Printing a File

The file currently opened in the Notepad application can be printed as follows:

- Use *Page Setup* and *Printer Setup* as explained above to decide the page layout and printer settings.
- Click on *File* in the top level menu bar.
- Click on *Print*.

B.2.7. Exiting the Notepad Application

To exit the Notepad application, click on *Exit*, under *File* in the top level menu bar.

APPENDIX C: INSPECTION REPORT & PONTIS DATA FILES

This appendix lists the inspection report created by the ADC program and the Pontis data files created by the PDFC program.

C.1. Inspection Report

BRIDGE ID: 0344.3S076 Res. No. 24 FHWA No. 013691
 a 66 ft x 44 ft Type: Prestressed Beam
 CARRYING ROUTE Iowa #76 OVER Small Natural Stream
 LOCATED 5.6 miles S of Minnesota State Line

E.#	El. Name	Ttl. Qt.	1	2	3	4	5	EC
101	Deck-Unprt.	2904.00	100.00	0.00	0.00	0.00	0.00	1
102	Slab-Unprt.	1200.00	63.33	10.00	26.67	0.00	0.00	1
103	Box-Unprt.	1000.00	680.00	20.00	200.00	100.00	0.00	1
131	Bottom of D,S or B	2904.00	100.00	0.00	0.00	0.00	0.00	1
241	P.C. beam	462.00	100.00	0.00	0.00	0.00	0.00	1
256	R.C. IntAbut beam	88.00	100.00	0.00	0.00	0.00	0.00	1
314	Aluminum railing	143.00	100.00	0.00	0.00	0.00	0.00	1
321	Conc. Appl. Slab	2.00	100.00	0.00	0.00	0.00	0.00	1

SMART FLAGS:

336	Steel Connections	1	0.00	0.00	100.00	0.00	0.00
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Inspection date: 3/11/94
 Inspector's name: John Brown

C.2. Pontis Data File: XXX.000

Bridge_ID
EinspMoYr
EinspDay

"213"	Feb-1992	6
"602510"	Jul-1994	13
"013691"	Mar-1994	11
"2121"	Mar-1995	4
"013401"	Mar-1994	11
"022370"	Jul-1994	8

C.3. Pontis Data File: -XXX.ELM

Elem	Quant	Pct2	Pct3	Pct4	Pct5	Envt
"213"						
012	100.0	11.0	00.0	00.0	00.0	1
038	100.0	00.0	00.0	00.0	00.0	1
013	1000.0	21.0	00.0	00.0	00.0	1
"602510"						
062	5520.0	00.0	00.0	00.0	00.0	1
060	5520.0	00.0	00.0	00.0	00.0	1
109	966.0	01.0	00.0	00.0	00.0	1
272	080.0	10.0	00.0	00.0	00.0	1
276	172.0	02.0	00.0	00.0	00.0	1
279	162.0	00.0	06.5	00.0	00.0	1
333	277.0	10.1	00.0	00.0	00.0	1
321	002.0	00.0	00.0	00.0	00.0	1
370	001.0	00.0	00.0	00.0	00.0	1
"013691"						
012	2904.0	00.0	00.0	00.0	00.0	1
071	1000.0	20.0	200.0	100.0	00.0	1
060	2904.0	00.0	00.0	00.0	00.0	1
109	462.0	00.0	00.0	00.0	00.0	1
272	088.0	00.0	00.0	00.0	00.0	1
333	143.0	00.0	00.0	00.0	00.0	1
321	002.0	00.0	00.0	00.0	00.0	1
374	001.0	00.0	100.0	00.0	00.0	1
"2121"						
012	100.0	20.0	00.0	10.0	00.0	1
038	2445.0	00.5	00.5	00.0	00.0	1
357	001.0	00.0	00.0	100.0	00.0	1
"013401"						
012	400.0	11.3	08.5	00.0	00.0	1
022	6272.0	00.0	00.0	00.0	00.0	1
060	6272.0	00.0	00.0	00.0	00.0	1
109	1176.0	00.0	00.0	00.0	00.0	1
272	064.0	00.0	00.0	00.0	00.0	1
276	170.0	00.0	00.0	00.0	00.0	1

279	184.0	00.0	00.0	00.0	00.0	1
331	424.0	00.0	00.0	00.0	00.0	1
321	002.0	00.0	100.0	00.0	00.0	1
"022370"						
012	6356.0	00.0	00.0	100.0	00.0	1
060	6356.0	00.0	00.0	00.0	00.0	1
109	1135.0	00.0	00.0	00.0	00.0	1
215	056.0	07.1	00.0	00.0	00.0	1
275	056.0	00.0	00.0	00.0	00.0	1
276	186.0	01.0	00.0	00.0	00.0	1
279	216.0	00.0	06.5	00.0	00.0	1
311	010.0	100.0	00.0	00.0	00.0	1
321	002.0	00.0	00.0	00.0	00.0	1
359	001.0	00.0	00.0	00.0	00.0	1