Abridgment

Revitalization of a Suite of Bridge Analysis Codes

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Five bridge analysis codes, which formerly ran only on mainframes and minicomputers, have been enhanced and converted to the microcomputer environment. Refinements include color pre- and postprocessing graphics, panel-oriented input, help and error trapping functions, and an improved user interface. Bridge applications include linear-elastic analysis of beam columns subjected to movable loads, linear and nonlinear frame analyses, and analysis of bent caps and continuous beams. Seamless integration of coded modules is performed so that existing mainframe programs become subroutines to the new microcomputer codes. However, no other modifications are made to the analysis codes to ensure avoidance of new error sources and rapid harmonization.

A large number and variety of mainframe computer programs are in current use by bridge engineers for analysis and design of structures. State highway departments typically have a large library of FORTRAN codes that were each written for a special purpose. Although these codes perform their intended analytical functions, most were written without programming enhancements, such as color graphics, which can simplify data input at the preprocessing stage and graphically summarize output. Engineers currently must sift through large quantities of numerical data in order to interpret results. Other than painstakingly "checking" by hand, no facile means of verifying geometry, materials, and support locations is available to an analyst before execution of the code.

The primary purpose of this effort is to use currently available microcomputer hardware and software to enhance existing mainframe analysis programs toward optimum usefulness for design engineers. Not only are the analysis programs executable at the engineer's own desk, but panel input and graphics capabilities allow error checking before the more time-consuming analysis code is executed. Every effort is made to leave the current analysis program unmodified so that new error sources are not introduced. As a general method of approach, languages and routines that are within the mainstream of engineering and scientific computation are employed. FORTRAN 77 is used as the primary language for new code development.

CODING PHILOSOPHY AND ORGANIZATION

The primary objective of this study is to provide generic pre- and postprocessing codes that can be quickly modified to suit different programs. As a consequence, each program is structured to be modular, with each of six modules operating completely independent of the others. All modules are integrated using a main program that provides the end-user control over the entire process by means of a master menu structure (see Figure 1). The generality and stand-alone nature of these modules make conversions of new codes a relatively simple task. Altogether, five analysis codes have been updated. One code was completed during the first year, and the remaining four codes were converted in the second year of a 2-year effort.

Analysis codes treating a variety of commonly used bridge components, including beam columns, bent caps, continuous beams, and linear and nonlinear frames, were converted to the new environment. BMCOL51 performs finite-element simulation of a linearly elastic beam column whose flexural stiffness may vary along the length and is subjected to fixed and movable loads (*1*). Frame analysis capabilities are provided through FRAME11 and FRAME51 (*2,3*). FRAME51 considers geometric, material, and support nonlinearities of statically loaded plane frames, whereas FRAME11 provides a linear-elastic finite-element solution for the same structure. In both frame codes alphanumeric and graphical results are available for axial, lateral, and rotational displacements as well as for axial, shear, and moment functions. Linear-elastic analysis of a bent cap subjected to fixed and movable loads applied according to AASHTO lane loading requirements is carried out by CAP18 (*4,5*). B30 (*6*) analyzes composite and noncomposite beams with P-loads. In all cases graphical postprocessing similar to that shown in Figure 2 is provided.

The engineer, as user, makes selections from pull-down menu structures according to the task to be accomplished. In

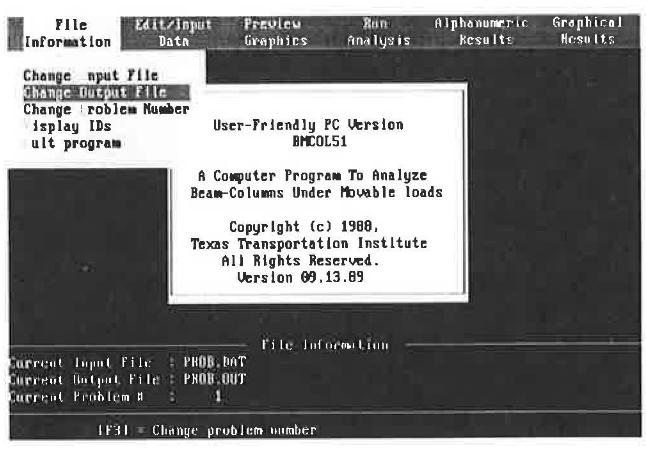

FIGURE 1 Main menu and screen layout.

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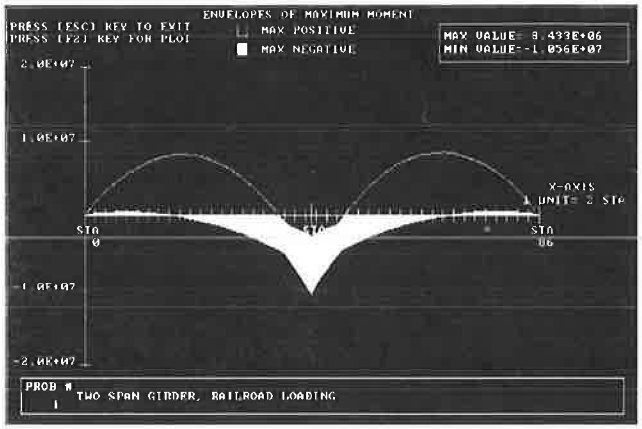

FIGURE 2 Envelope of maximum moment.

the current microcomputer version the input and output files are identical with those of the mainframe version, which allows interchange of ASCII files between microcomputer and mainframe, should that be desirable. Approximately 10,000 to 15,000 lines of new code are added to each of the existing analysis codes. By means of overlays, execution size is always below 600 kilobytes.

CONCLUSION

Five user-oriented analysis packages that are in constant use by the Texas State Department of Highways and Public Transportation have been updated to significantly reduce input preparation time for initial runs as well as to simplify modification procedures to the data file for additional trial runs. Graphics pre- and postprocessors enable the bridge analyst to quickly detect obvious errors or omissions in data files and facilitate understanding of the output. Hard-copy output from a microcomputer conveniently located at the designer's local workstation encourages consideration of alternative structural designs. The modular approach taken for coding organization can be readily applied to other codes in need of enhancement.

A diskette containing executable code and a sample input file as well as documentation for each program can be obtained from the Communications Division, Texas Transportation Institute, Texas A&M University, College Station, Texas.

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