SET

Microcomputer as Structural Engineering Tool

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Abstract:     Microcomputers have changed our world. No longer are a
              limited number of people using computers, but they are
              everywhere central to our existence.  Sometimes it is
              true we are not aware of them any more, we are simply
              using microcomputers.

              The intention of this paper is to present the micro-
              computer as a tool, the working aid to gain better,
              reliable and more economical design in the range of
              structures humans build today.

              The software presented can solve most of the structural
              analysis problems in civil and mechanical engineering
              but can also be applied to other fields of engineering.

              Rapid increase in microcomputing power will in the
              next few years bring this tool onto everyone's desk
              and we will use it every day as an engineer uses a
              pencil today.

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MOTS-CLÉS

Structures, analyse, ordinateur

SOMMAIRE

Les microordinateurs ont changé notre monde. Le nombre de gens qui
s´en servent n´est pas limité, on les emploie partout, dans
le milieu où nous vivons et parfois même nous ne les "voyons"
pas pour ainsi dire, nous les utilisons simplement.

Le but de cet article est de montrer le microordinateur comme
outil à l´aide de duquel nous pouvons obtenir un projet qui
est mieux, plus sûr et plus économique dans la rangée des structu-
res que les hommes bâtissent actuellement.

Le logiciel qui est présenté pourrait résoudre la majorité
des problèmes concernant l´analyse de la structure dans la
pratique quotidienne des ingénieurs de ponts et chaussées et
de mécanique mais il pourrait âtre utulisé dans d´autres domaines
d´ingénieurs aussi.

L´acroissement rapide de la force des microordinateurs nous
permettra dans quelques années d´avoir cet outil sur tous les
bureaux et nous nous en servirons, comme les ingénieurs utilisent
les crayons aujourd´hui.

## 1.0 INTRODUCTION

Rapid increase in microcomputing power has enabled software development to take place at the microcomputing level. Computer hardware is gradually becoming cheaper and cheaper every day and it is now within the financial reach of most structural engineers on a personal computing level. The intention of this paper is to introduce microcomputers as a tool, the working aid to gain better, more reliable and economical design of the structures humans build today.

The development of the software presented started in the mid seventies on HP9830B microcomputers and is today available on IBM PC, FM-8, SAGE II (IV) and ATARI 520 ST Computers.

## 2.0 THE PROGRAM

The microcomputer program SET (Structural Engineering Tool) makes available to the user a wide choice of Finite Element Analysis (FEA) on a microcomputing level.

A design procedure in Structural Analysis in civil or mechanical engineering requires repetitive calculations leading to high costs on a mainframe. Usually the mainframe FEA programs run in batch processing but a Structural Engineer needs our interactive program at low costs, yet not available on mainframes.

SET performs a user selected analysis in Structural Mechanics and a two dimensional analysis in Continuum Mechanics.

SET is executed from a Master (Main Menu) program allowing the following Modules:

- SET (Structural Engineering Tool)
- EDIT (Editor for Data Files)
- DISPLAY (Display results on screen)
- PRINT (Print results on printer)
- SYSTEM (Set graphics parameters)

The Master program will establish a module that will be executed in sequence, the control is then returned to the Master.

## 3.0 SET module

The Structural Engineering Tool Module consists of the following submodules:

1 - Plane Truss
2 - Plane Frame
3 - Continuous beams and plates
4 - Heat transfer using triangular elements
5 - Plane stress triangular elements
6 - 8-mode Isoparametric elements
7 - Space Truss
8 - Space Frame
9 - Automatic Mesh Generation of triangular elements
10 - Automatic Mesh Generation of isoparametric elements

SET input is interactive for the first run of the specific problem but if the data are provided from automatic mesh generation (submodules 9 and 10) the input is from the default file generated by the submodules.

## 4.0 Analysis Methods

Each Analysis procedure is designed to solve a particular type of problem using the Matrix Displacement Method. The finite element procedure, with displacements as unknowns, is used to calculate displacements and stresses (forces or strains) throughout the structure. Linear elastic stress-strain laws are assumed.

Each individual analysis provides facilities for the integration and assembly of the stiffness matrices, the application of supports (loads), and stress computations. The methods of the solution of equations vary for different submodules to accommodate the most efficient calculation for the particular problem. The Gauss-Jordan elimination method is most commonly used, but the Frontal Solver is implemented in submodule 6.

## 5.0 Conclusion

A comparison of time spent on a particular problem between SET and some mainframe packages is clearly on SET side by a factor of (at least) 5 for a single and successful run and can go up to 20 for a repetitive calculation. The output from SET is user friendly allowing facilities of immediate screen hardcopy, results listing on the screen or on the printer as well as instant editing on screen.

The complete description of the SET package can be found in reference 1.

REFERENCES

1. B. Bedenik, "SET-Structural Engineering Tool", Ellis-Horwood Ltd, Chichester, 1986.

# Three-Dimensional Analysis and Optimum Design of Building Structures

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KEYWORDS

3-D Analysis, Construction sequence, Optimum design, Discrete solutions

ABSTRACT

This paper concentrates on the practical application of optimum design technique for building structures and on the techniques of three-dimensional analysis of building structures. Two unique features of structural analysis in this paper are; 1) the use of rectangular plate element with cut-outs, and 2) the consideration of the effects of construction sequence in structural analysis. The benifits of this improved analysis is materialized by the optimum design of the structure. The structural optimization is carried out in two different stages. The discrete optimum solution for the members in the structure is obtained from the pseudo continuous solution with the stress constraints. Then, the total building structure may be optimized with displacement constraints through the repeated reanalysis and redesign. These analysis and design techniques of building structure is integrated into BUILDS system.