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Application of Computers for Structural Engineering in an Italian Research Institute

G. Oberti and A. Peano

1. Introduction

The purpose of this short paper is to take a short of the current use of computers in a large consulting and research institute, such as ISMES.

The Mathematical Modelling Division of ISMES (Bergamo-Italy) was initiated in 1970 and has now grown up to about 50 engineers or programmers.

Most of the work is performed by means of the in house computer: a VAX-11/780 with six Megabytes of central memory and four discs for a total capacity of 1200 Megabytes.

Two high speed tape units, two line printers, two plotters and 30 alphanumeric or graphic terminals are also available. The computer system is also accessed by 5 remote terminals in various Italian towns. A second VAX is now being added by means of a Ethernet link.

The services offered by the Mathematical Modelling Division are in order of increasing engineering content:

- Data processing of instrumentation records (data bases of geological, geo-technical, seismic and structural engineering data).
- Finite element analysis.
- Computer aided design and consulting.
- Problem-oriented research.

Of course these services require a large amount of advanced software which is either developed in-house or procured from external sources. Recently ISMES has also decided to market some of its software systems.

For instance the finite element software FIESTA has some capabilities which are unique worldwide.

The most important is a capability for assessment of the accuracy of the computed solution and automated recovery of a reliable one, if needed, using more degrees of freedom. For this reason McDonnel Douglas Automation Company has required and been assigned a licence to market the FIESTA system worldwide. Among the first few users are the US Army Corps of Engineers and McDonnel Douglas Aerospace Company.

ISMES is also marketing some interactive graphics systems for design of embankment and arch dams.

2. Examples of Application of Computers in Structural Engineering

Some of the more usual or more significant problems analysed by the Mathematical Modelling Division of ISMES during the last two years are as following:

2.1 Concrete and Masonry Structures

- Seismic analysis of nuclear reactor buildings.
- Aircraft impact analysis on reactor buildings.
- Backfitting of historical buildings.
- Turbo alternator bearing structure stiffness analysis.

- Dam analysis (Preliminary design; static and dynamic FEM analyses; models for structural monitoring of dams and their foundation).

2.2 Soil and Rock Mechanics

- 2D and 3D modelling of the excavation of several underground pumped storage power plants.
- Embankment dam design (seepage, construction, seismic and slope stability analysis).
- Geotechnical aspects of the excavation of Milano and Naples undergrounds (settlements of adjacent buildings, design of sheetpile retaining walls, seepage analysis, etc.).
- Thermomechanical analysis for a nuclear waste repository in a deep clay deposit.
- Site specific response spectra.
- Earthquake source and propagation models.
- Seepage analysis for monitoring the dewatering of a nuclear power plant foundation.
- Geothermics: field models including change of state; fractures opening models; subsidence effects.

2.3 Mechanical Engineering

- 3D modelling under various design conditions of thick components: valves, nozzles, etc.
- Thermomechanical analysis of reactors and other components for petrochemical plants.
- Fracture mechanics analysis of the bifurcation of a penstock.
- Design of the spent fuel racks for a BWR power plant.
- Elastic plastic buckling analysis of various components: a perforated casing for a geothermal well, an elbow pipe of an aqueduct, a vessel of a LMFBR.
- Trajectory analysis for a washing machine including gyroscopic effects and special dampers. Analysis of the stresses induced in the case by the accelerations during the starting phase.
- Elastic plastic buckling and other analysis of a submarine for oil exploration.

3. Discussion

The full range of structural engineering problems is currently tackled at ISMES. By all standards (volume, conceptual complexity, range of interests) the computer use at ISMES seems to be the most important in Italy in the area of structural engineering.

This is mainly due to the continuous flow of stimulating practical problems and to the financial support (e.g. research grants) offered by the Electric Power Board of Italy (ENEL) which is the main shareholder of ISMES.

The increasing involvement of ISMES with problems posed by nuclear and conventional power plants stimulates further development for instance in the area of computer aided design and drafting and in the area of advanced CPU-intensive nonlinear applications.