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Problems Related to the Use of Computers

Problemes relatifs a l'emploi des ordinateurs

Probleme bei der Verwendung von Computers

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Summary

In dealing with computers and their versatility, designers have to keep clear in mind the methodology of analysis, the approach to practical solutions, the discrimination of parameters, the discussion of models, the judgement of model limits and results. Factors are sometimes conflicting; available time and cost, users receptiveness, scientific improvement, extent of study and responsibility. Two engineering fields are outlined: structures and hydraulics at the design stage, operation and control of structures during and after construction.

Résumé

Lors de l'utilisation d'ordinateurs les ingénieurs doivent garder à l'esprit les méthodologies analytiques, l'approche de solutions pratiques, la discrimination des paramètres, la discussion des modèles, l'appreciation de leurs limites et leur validité. Les facteurs sont parfois en conflict: temps et coût disponibles, réceptivité des usagers, développement scientifique, importance des études et responsabilità. Deux domaines d' application sont mis en évidence: structures et hydraulique lors de l'étude de projet, fonctionnement et contrôle des ouvrages pendant et après la construction.

Zusammenfassung

Bei der Computeranwendung im Ingenieurwesen sind folgende Faktoren zu beachten: Berechnungsmethode, Weg zur praktischen Lösung, Parametervariation, strukturelle Modelle, Grenzen und Resultate der Modelle. Dies unter den Randbedingungen: Verfügbare Zeit, kosten, Stand der wissenschaftlichen Erkenntnis, Voraussetzungen der Benützer und Verantwortlichkeit. Am Beispiel der Anwendungsgebiete Statik und Hydraulik werden die aufgezeigten Probleme diskutiert.

1. METHODOLOGY

With the advent of computers, designers find themselves confronted by a substantial and rapid evolution of the criteria to be followed in their work.

Such an evolution allows the use of a vast field of techniques of analysis, made up from an almost unlimited capacity of the computers, that in principle contribute to exploration and possibly resolution of problems of engineering practice which are diverse sophisticated and multi-discipline.

Confronted by such a situation, so favourable with regard to the investigative possibilities, the designers, who in the end find themselves in the responsible position for the conception and realization of the project, are called upon to face problems of choice, use and guidance of the analytical tools at their disposal.

To be able to make the best use of the resources and versatility of methods of calculation for a practical result, the following criteria must be taken into account:

- Specify the mechanics of the problem to be resolved and focus the approach to the solution: such a criterion is not strictly bound to the use of modern techniques of calculation but gains importance for the following steps;

- Define the validity of the starting parameters and of the data initially available, in as much as the input is frequently incomplete or partially missing: the initial calculations will give best results in parametric form;

- Discuss the models which will represent the real structures;

- Understand the numerical analyses and their programming, maintaining an almost continuous contact between the computing centre and the designers;

- Judge the limits and validity of the mathematical models and their results: it is during this most critical phase of the process that the reciprocal contribution of the designers-calculator assumes the greatest importance;

- Derive the conclusions and conserve the autonomy of the decisions with regard to the practical utilisation of the analysis.

The observance of such criteria is not easy. Experience teaches in fact that in the development of project activities and use of computers there can arise situations, at times conflicting, which must necessarily be resolved, such as:

- time and funds at disposition, not so much concerning the actual execution and work of the computers but rather in relation to the activity at the interface;

- loss of the physical feeling regarding practical engineering problems;

- receptiveness of those people who in the end must use and put into practice the results from the technical calculations;

- motivation for the search for scientific developement;

- questions of trust and responsibility.

2. FIELDS AND APPLICATION

From the various engineering disciplines where the concept computer-designer is in current use, two fields may be pointed out:

2.1 Structural and Hydraulic Fields in the Project Stage

The application of modern techniques of numerical analysis with the use of computers, is particularly useful in the examination of variables, above all when the initial parameters are not well defined. With the study of the variables the designer has at his disposal the possibility of choice and must keep clear in his mind the possibility of not being in possession of the best definitive solution. Such cases are typically those in which infrastructure and foundations are concerned, frequently lacking sufficient survey information and consequently precise input (for example the mechanical characteristics of rocks and soils).

In superstructures, computers can easily optimise dimensions of civil structures, excepting when they must be drastically modified because for example of later definition of mechanical parts which the structure must receive.

In the purely hydraulic field computers are utilised very effectively for extending records of partial data for example in the calculation of spillway capacity, and the minima for operation of the system with optimisation of the corresponding static hydraulic structures.

2.2 Field of Operation and Control of Structures

In the field of operation and control of the structure modern methods are used to fix the manuals for operation of the works, the static hydraulic and dynamic controls for verifying the changes and foreseeing the trends. The possibilities for use are considerable, with the condition that all are kept under reasonable control.

At first sight, seen in a unilateral form through the eyes of the responsible designer, it may be said that the benefits of modern techniques of analysis do not have need of proof and demonstration while the drawbacks increase in the proportion in which the methods are confused with the scope, the means with the products, the trust with the self-criticism.

3. ACTUAL EXAMPLES

3.1 Choice of a Type of Dam (Fig. 3.1)

The problem posed was that of planning a large concrete dam with a height varying between 60 and 180 m, and a crest length of 1 500 m, founded on an interbedded foundation of basalt and breccia.

The structure had to be mass-gravity or hollow-gravity. There was a requirement to proceed with the structural decisions and general layout having still limited data on the mechanical characteristics of the foundation, with also incomplete information on the technical and economic aspects of alternatives. The use of a computer was essential to deal with the comparative examination of stresses and deformations of the dam-foundation as a whole derived from different alternative combinations of the variable factors let alone, as well as to obtain the indicative estimates for the works.

The study was conducted on parametric bases not so much to define the best final solution, but to determine the influence of every variable factor, with appropriate alternatives and stated hypotheses. Such variable factors were: type of dam, height of structure, geometry of the excavation, stratification of the rock, homogeneity and discontinuities in the foundation, moduli of deformation, conditions of loading.

The systematic study allowed the problem to be solved without restricting the breadth of enquiry and field of validity of the results.

It is useful to point out that in the course of such analysis numerous classic hypotheses have been ratified, and sometimes also corrected, opening the way to further analyses of optimisation still using computers and afterwards physical models.

3.2 Structural and Hydraulic Study of a Spillway (Fig. 3.2, 3.3)

The question was of studying the most feasible technical and economical solution for passing exceptional floods from a basin used for hydroelectric purposes. The input data constitued two hurricanes having respectively peak floods equal to 12 000 and 9 000 m^3/sec, with flood volume of 1 000 and 1 500 millions m^3: to the hurricane of greater peak, corresponded the smaller flood volume.

The variables to be considered consequently were the following: the occurrence of the first hurricane or of the second, or of both assuming variable intervals between the first and the second and considering the case of the first followed by the second and viceversa; the volumes impounded for the greatest possible flood routing with the purpose of protecting the area downstream: the levels of the spillways, the type of open-air works and tunnel spillways, the dimensions of the gates, the static and hydraulic structures, the quantities for the works and their cost.

With the use of the computers as well, in relatively simple programmes of calculation the alternatives were examined and the practical solutions optimised satisfactorily. Notwithstanding the noteworthy mass of work computerised and translated into drawings for the project, this was not sufficient; in fact the problems of erosion downstream of the structure were not considered and the designer had not paid sufficient attention to the possibility that some of the gates might not be operating producing unsatisfactory consequences hydraulically and statically on the structures theoretically optimised.

The example quoted here is typical of the possibility of forgetting particular points in the course of analysis, confronted by the need to deal with problems of practical engineering: the responsibility is certainly not in the use of computers but in not giving to the computers the whole of the problem to be resolved.

3.3 Operation of a Hydroelectric System

The question was that of a system of power plants in series where for energy motives the reservoirs had to be generally maintained at the highest levels possible within the limits of safety.

The despatching operation centre had constructed a model evidently based on the optimisation of the production of energy and removing autonomy for decision from the local control.

During the period of heavy precipitation the local operators obeying their instructions were opening the gates of the spillway following the orders given to them from the centralised model. In a period of heavy rainfall, however not exceptional, the operators had advised the despatching centre of the opportunity for lowering rapidly the impounded levels to progressively prepare the hydraulic works for absorbing the incoming water volume without danger. The despatching centre had not accepted the suggestion and had not ordered in time the opening of the gates in view of the imminent danger of overtopping.

When finally the decision was taken, the situation had reached the point of catastrophe, the gates could not be opened completely and in time, the levels of the reservoirs went over the allowable level, and overtopped two earth embankments which were almost completely destroyed.

This case is cited as an example of loss of flexibility in the use of a predetermined model considered incorrectly to be perfect.

4. CONCLUSIONS

The following main conclusions are drawn:

- input data are often incomplete or with parts missing, particularly concerning infrastructure - foundation characteristics and therefore it may be wrong to completely rely on the computed results;

- models are never perfect nor complete and therefore problems should be analysed parametrically in order to derive the rational choice of solution;

- although designers and users should autonomously make the final decisions, computing centres and their programmers should be ready to contribute to the interpretation and understanding of the interface steps and of the limits of applicability of the algorithms used.

Annexes: Fig. 3.1, 3.2, 3.3.

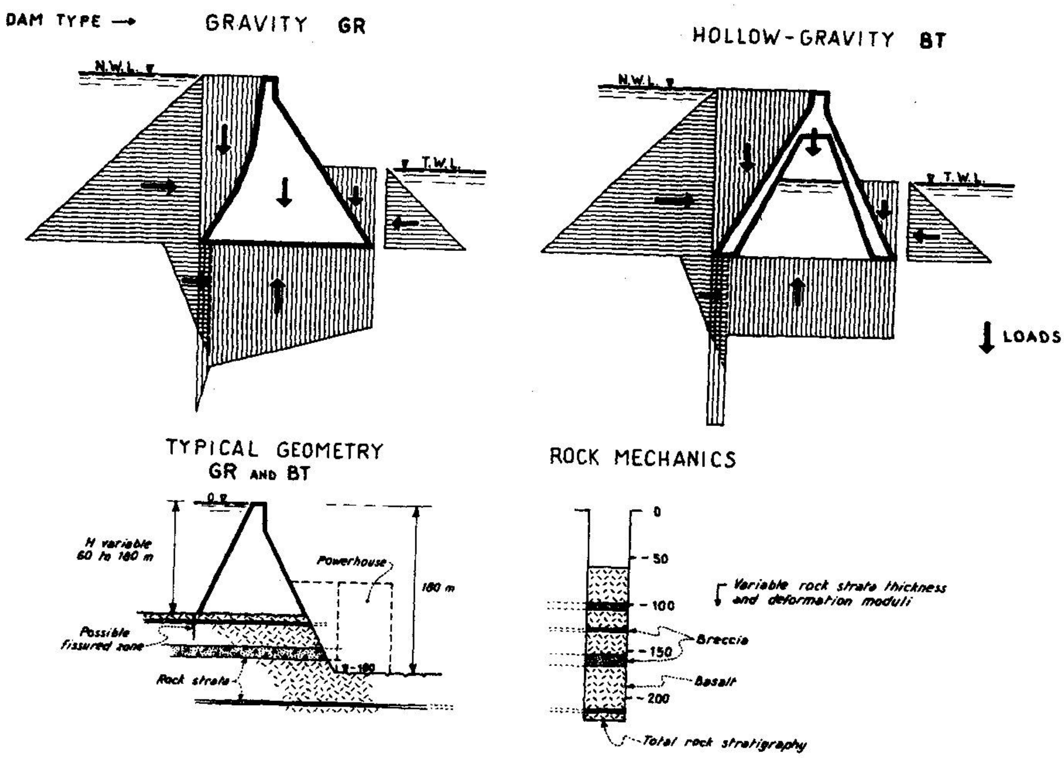

Fig. 3.1 - Investigation on dam-foundation complex

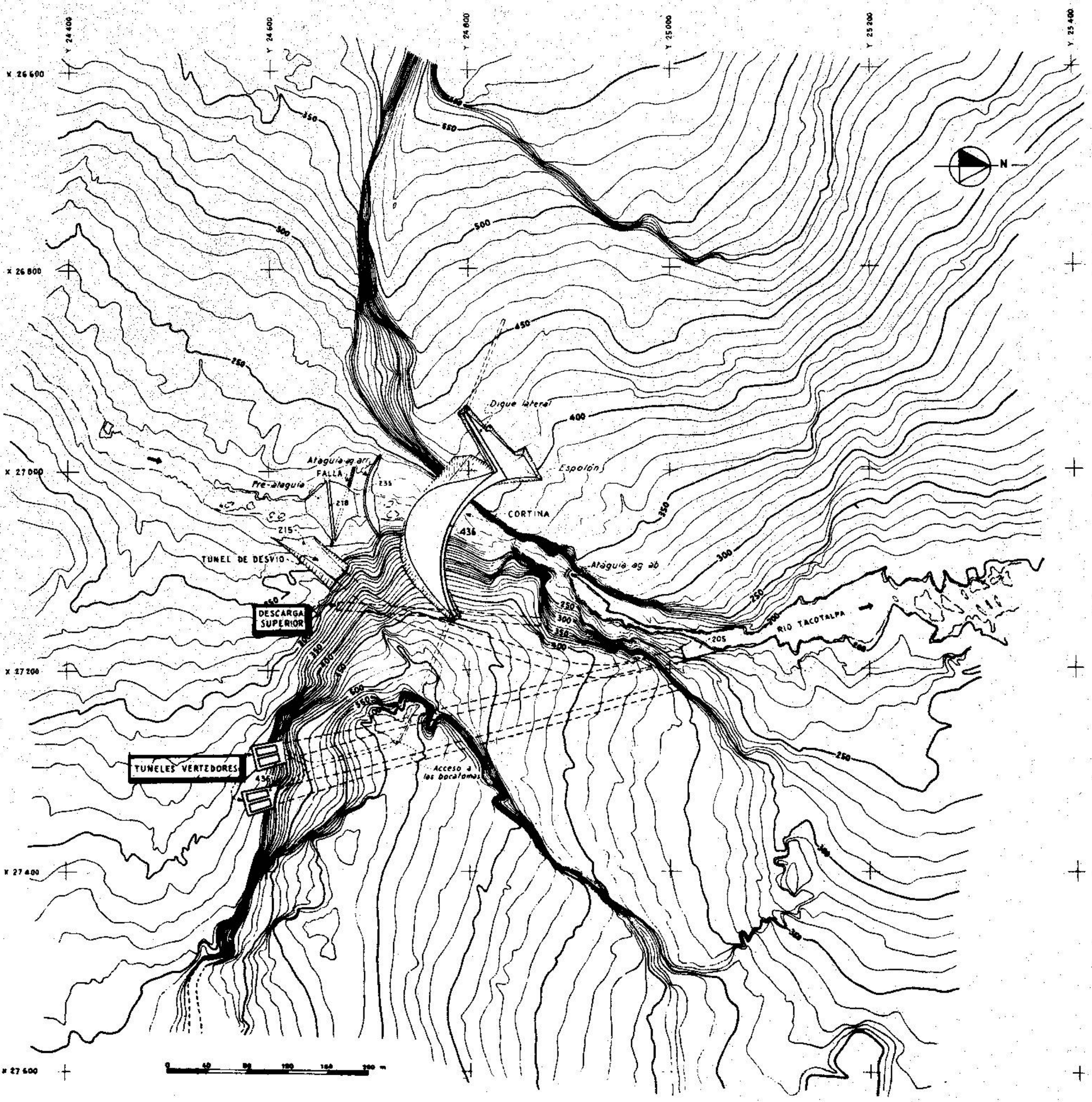

Fig. 3.2 - Study of dam-spillway alternatives. Layout

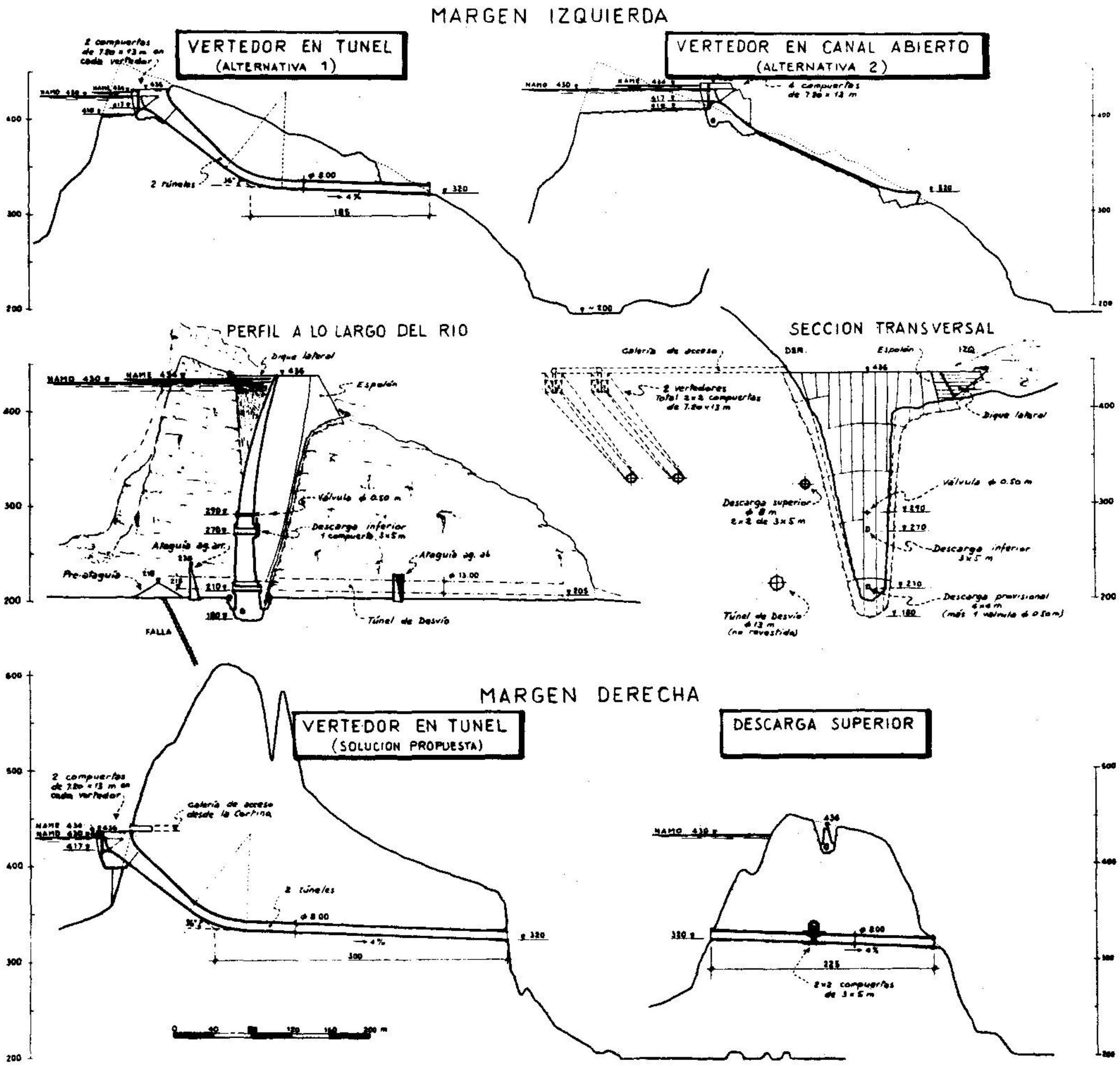

Fig. 3.3 - Study of dam-spillway alternatives. Sections

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