AN APPROACH TO THE SELECTION OF THE OPTIMAL METHOD OF DRAINAGE IN SURFACE EXPLOITATION OF MINERAL RESOURCES

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ABSTRACT

This paper presents the selection of the optimal drainage system problem in the form of the data system whereby all parameters are intergrated for the selection of the drainage method and for possible drainage methods for the particular type of pit. Selection of the optimal drainage system out of all possible solutions is done by the method of sorting out and elimination. An algorythm for the selection of the optimal method of drainage is shown together with the methodology of starting parameters registration whereby an electronic data processing may be applied, and the total synchronization of all operations that follow an optimal drainage system is achieved.

1. Introduction

When selecting the optimal method of surface pit drainage, where an application of numerous drainage systems is envisaged, we come across the complex problems of technical, technological and organisational nature. To make the right decisions and the best solutions it is advisable to consider all aspects of the problem, to make a selection of relevant and non-relevant components and assess many various facts that act in different ways, quality and quantity wise, upon total effects of drainage. The selection of the optimal solution can only be done after the complete consideration of all possible solutions. A detailed furnishing of all necessary data which are common to all solutions, or are specific to particular solutions, must be carried out. Such an approach requires processing of many data, but the introduction of computers and automatic data systems have widened a number of possibilities of analysis and selections of many variables.

Mathematical modelling, method of optimisations and informational systems are indispensable for mastering of the problems of the drainage optimisation. This paper furnishes basic considerations in connection with starting elements at the drainage optimisation and presents the method of sorting out and elimination that can easily be applied to the protection from surface water. Informational system is presented as a course of forming and as a sequence of some operations with the selection of correct and logic coding.

Starting elements, needed for the selection of the optimal method of drainage, contain: typical data, limiting data and criterion of optimisation.

Typical data present all elements that typifies location in the context of drainage and hydrogeological complexity of the location, as well as the elements which are typical for the applicable method of drainage.

Limiting data are meant to be those types of starting elements that limit the possibility of application of particular drainage methods (for example, watertight screens at the course of indefinite depth containing water etc.) so that they can be added to the group of the limiting conditions.

Selection of the optimal method of drainage is not possible without the criteria of optimisation, that can vary subject to the component, which one would point out into the foreground (for example, minimum duration needed for building the drainage structures, minimum furds invested in the drainage equipment, maximum protection from surface and subsurface waters etc.). Experience has shown that, when selecting the choise of optimisation, one should opt out for the minimum costs for the drainage requirements in relation to total costs per production unit.

2. SELECTION OF THE OPTIMAL METHOD OF DRAINAGE

Selection of the optimal drainage system out of all possible solutions and out of the optimal group of variables, which are derived by way of modelling, can be achieved by the method of sorting out and elimination which had been worked out by M. Vasilewski. According to this method, all variables of drainage are called general sum of variables. The general sum of variables consists of at least two groups of variables, whereby under a variable one should consider at least two variables with the same or similar characteristics. Maximum number of drainage variables determines the quantitative degree of the general sum of variables.

Ono should, by way of algorythm of selection of optimal drainage method, adopt such a methodology of registration of starting parameters (limiting and typical data, analysis of costs etc.) which enables forming of unique informational system as well as the possibility of electronic data processing. That is why the classical computer methods are not applicable for there is a great deal of information which are acquired by the principle of sorting out and elimination.

If R denotes the general sum of variables P_i, where $i = 1,2, \ldots, n$, then in each variable of P_i we are able to describe a definite number of data (C_i, α, k). α denotes the number of data, therefore $\alpha = 1,2, \ldots i$, and the number of expression K in each characteristical data is the same, therefore the expression K can be marked as S_i, because $K = 1,2, \ldots S_i$.

Forexample, for the two characteristical data of each drainage variable, we can set the following:

$$\{N_i, k\} = \varphi(\{C_i, \alpha, k\}$$

$$\{E_i, k\} = \Psi(\{C_i, \alpha, k\}$$

where φ and Ψ are directly depending on the adopted optimisation criterion. It can be adopted that the above are the linear combinations of the respective characteristic data, forexample, if it is determined that, as the optimisation criterion (function of the objectiv) those are to be the minimum investment costs, the aforesaid equasion shall look like this:

$$N_i, k = C_{i,1,k} + C_{i,2,k} - C_{i,3,k}$$

$$E_i, k = C_{i,4,k}$$

where:

$C_{i,1,k}$ - total investment costs,

$C_{i,2,k}$ - costs of the drainage structure

$C_{i,3,k}$ - depreciation of the drainage equipment

$C_{i,4,k}$ - costs of labour and materials used on the drainage works

Important factor at each drainage variable is the time needed for building of the drainage structure, which can be denoted as m . The year symbol, in the period of building the drainage structure m, where the first signs of characteristical parameters P_i of the drainage variable can be felt, could be marked as r_i and as the year, when the realisation of the particular drainage variable is started. In that way, the number of year j, where the sign of characteristic data k is felt, is worked out by equasion $j = r_i - 1 + k$. Deriving out of this, we are coming to the number of caracteristic data which determines the year:

$$K = j - r_i + 1$$

For the drainage variable P_i which is not envisaged for the realisation r_i is 0, whereas at other variables r_i has the values 1, 2, ... n. Using the main characteristic data we work out following values for every drainage variable P_i:

$$N_i = \sum_{K=1}^{S_i} N_{i,k}(1 + d)^{1-k}$$

$$E_i = \sum_{K=1}^{S_i} E_{i,k}(1 + d)^{1-k}$$

$$f_i = \frac{N_i}{E_i}$$

where:

N_i - total investment monies,

E_i - cost of the drainage structure

d - discount rate

Symbol f_i is usually called the characteristic coefficient for the drainage variable P_i.

The way we worked out f_i, which is marked as the characteristic coefficient, we determine also the limiting coefficient by use of limiting data.

The limiting data can be expressed thus:

$$\left\{ S_{y,l} \right\} \; ; \quad y = 1,2, \ldots q; \quad l = 1,2, \ldots p,$$

Every formula of limiting data presents also the sum of limiting data which are marked as y , so we can set it as follows:

$$S_{y,1} = \sum_{x=1}^{W} C_{i_x,y,1} = F$$

The above forms the limiting parameter F. It is understood that the solution of the function F will directly depend on the degree of limitation q, so we arrive at:

$$F = F (q)$$

or:

$$W = \frac{F (q)}{F (1)}$$

In this way we have determined the limitation coefficient.

By use of the characteristic coefficient Ff_i and the limiting coefficient W we arrive at the auxilliary group of variables out of the general sum of variables. By use of the optimisation of auxilliary variables, via the optimisation criteria (function of the objective), we arrive at the optimal group of drainage variables. If the optimisation criterion is expressed as:

$$K_{ij} = \sum_{k} K_{ijk}$$

where i = 1,2, ...n, denotes the auxilliary drainage variable, and j denotes the number of years working on realisation of the drainage structure, and where k denotes the number of typical data, which determines the year j by the fixed limiting data. It is possible that the partial costs of each variable can be added to the formula above which at the discoun rate d has the following value:

$$K_j = \sum_{j} K_{ij} (1 + d)^{1-j}$$

It can be concluded that the optimal drainage variable is the one that has the minimal function K_j.

The entire problem of selection of the optimal drainage system can be presented in the form of the informational system set out in Fig. 6.1. In the informational system there are four distinct zones: data preparation zone, data processing zone, utilization programme zone and extreme results zone. In the data preparation zone a processing of base for the selection of the drainage method is formed for drainage of the surface pits. The base for the selection of the drainage method requires the utmost knowledge in detail of the pit's geological consistense as well as its hydrogeological and geomechanical characteristics. Within the part of informations that process the drainage methods, it is dealt with the drainage equipment and structure within the framework of the particular drainage methods and with the number of labour structure and with the cost of each drainage method in process. The system elements within the data processing zone are directly depending upon the registration elements system form the data preparation zone. Those are sums of information which are, after having been coded and processed, directly fed into the utilization programme zone. The system elements within the data processing zone take in informations from the preparation zone and enable their translation into the respective machine language. This languago defines the group of binar ezpressed instructions for the respective computer.

The utilization programme zone is the most important zone of the informational system. Within that zone modelling of the proposed drainage variables is being done, optimisation criteria are being defined as well as typical and limiting data, and the selection of the optimal drainage system is carried out. Elements of the final results zone are defined by the elements out of preceding zones and are directly de depending upon the adopted optimisation criterion. The draina The drainage structure and equipment are usually determined within this zone. It is within this zone that the following is determined: the drainage structure and equipment, economic effects of drainage as well as the number and structure of labour that is employed in the realisation of the adopted drainage system.

One can draw a general conclusion that a complete synchronisation of all operations that monitor the selection of the optimal drainage system is achieved by the use of the informational system.

This system at the same time achieves a complete survey of all elements, which directly or indirectly, have bearing on making a definite selection of the drainage structure and equipment, which, with respective organisational structure, yields maximal economic effects expressed through the minimal drainage costs.

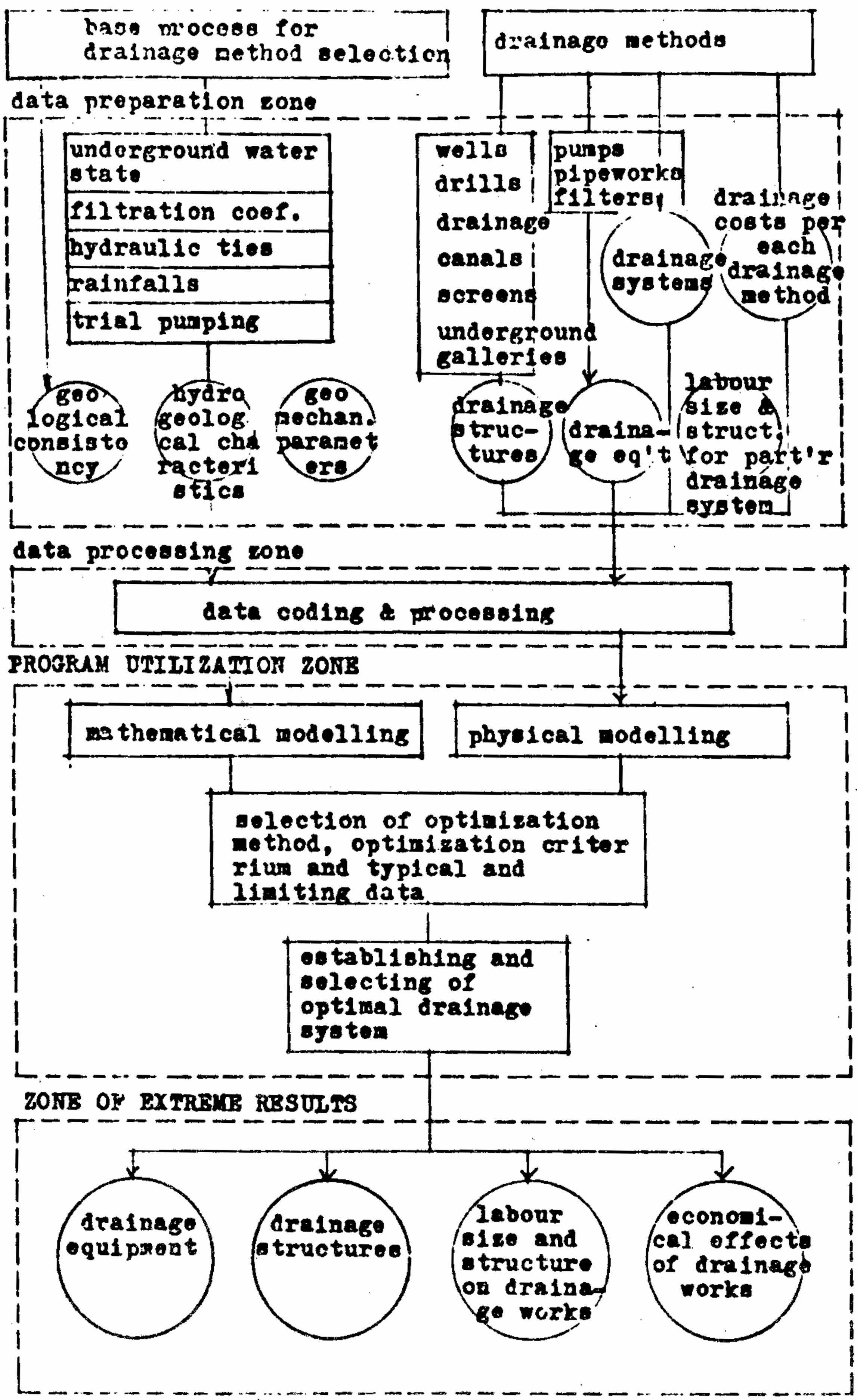

Fig. 6.1. General layout of the informational system for the selection of the optimal drainage method

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