DISCONTINUITY AND ITS SURVEY IN PETROPHYSICAL MODELS FROM THE POINT OF VIEW OF HYDROGEOLOGY

Gálos, M. - Kertész, P.

Technical University, Budapest
H - 1521 - Budapest, Hungary
Department for Geology and Mineralogy

SUMMARY

The paper presents a rock-model of engineering geology, the basic model elements of which are the rock block without discontinuity and the discontinuity itself. The determination of the character of discontinuity and the survey of the discontinuity-system are considered to be important from the point of view of hydrogeology since discontinuity is the elemental volume of water motion in solid rocks.

Elaboration of core materials of full core recovery borings allows to represent the measure of discontinuity /t_m/ i.e. the specific value for the discontinuity surface by the help of the discontinuity parameter /$t_{5,o}$/ or index of fissure /t_r/.

The index of fissure is suitable for pointing out rock bodies in rock masses having diverse hydrodynamical features due to their diverse discontinuity system.

The survey of a discontinuity-system serves as a basis for modelling water motion in solid rocks. Geometrical layout of the network inside rock bodies can be presented by the survey of the discontinuity-system. Correlation between model constans of the network model consisting of tubes with the same diameter and rock physical characteristics can be set up by the means of laboratory measurements.

INTRODUCTION

Rocks around engineering structures have to be modelled in order to solve engineering geological tasks during designing, building and operation, since interaction between engineering structures and rocks is so complex due to the complexity of the material world that it can be taken into account only by introducing simplifying conditions. According to rock modells of engineering geology based on petrophysics the rock mass in which the interaction takes place has to be chosen from rocky environment of the engineering structure considering the aim of our activity and being aware of our engineering activity. The shape and volume of the rock mass as elemental volume has to be determined considering both the effects on the rock mass and the geological conditions.

Rock masses can be considered as very heterogeneous elemental volumes. Some of their parts have different properties. The elemental volume within the rock mass which is considered uniform from the point of view of behaviour and so it can be separated and geologically having the same quality is called rock body. Rock quality changes on both sides of boundary surfaces separating rock bodies. The grade of change is the basis of the subjective decision by the means of which rock masses are divided into rock bodies.

Rock bodies in solid rocks are taken as discontinous volumes constructed of continous elemental volumes with the same quality. These continous elemental volumes which are uniform concerning our aims are called rock blocks.

When solving hydrogeological problems rock bodies consisting of rock blocks and the discontinuity of rock bodies are the model-elements by the means of which geological environment can be taken into account in accordance with real interaction of effects.

Discontinuity is the most important model element in the case of water motion in solid rocks.

In broader sense boundary surfaces separating rock bodies can be considered as discontinuity too, with rock quality changing on both sides.

CHARACTERISTICS OF DISCONTINUITY

Every characteristic property of discontinuity depends on the conditions of its formation, i.e. on the effects which created them or which affected them since their formation.

From the of view of genetics rock boundary sets up contemporaneously during rock formation. Discontinuity generally sets up in epigenetic way afterwards /eventually artificially/. Both discontinuity boundary surfaces and geological boundary surfaces are considered as planes in the case of proper geological conditions and they are characterized and taken into account by plane characteristics, i.e. by trend, direction of dip and angle of dip.

Discontinuity is considered as open if openings of discontinuity between adjacent rock blocks are occupied by aeroform or fluid materials. Discontinuity is considered as filled if a part of the opening is filled by some extraneous solid matter.

Discontinuity is considered as closed if filling material gets into a material structural tie-up causing discontinuity to loose singular character. Frequency and density of discontinuity is interpretated as specific surface occupied in the investigated elemental volume /rock body/. The parameter of joint faces /A in m^2/ for a rock body with the volume of V m^3 is taken for the measure of discontinuity /fig.1/. This is the specific value of discontinuity faces i.e. the measure of discontinuity.

$$t_m = \frac{\sum A_{ti}}{V} \qquad m^{-1}$$

To determine specific value for discontinuity faces proves to be an easy task theoretically, but in practice it is much more difficult, since this value has to be given during preparation work on the basis of the elaboration of bore and disclosure materials. When characterizing properties of marked out rock bodies of sólid rock masses in connection with water motion it can be assumed, that rock blocks are not water permeable, consequently discontinuity or discontinuity system is considered as elemental volume for water. This is the reason why determination of discontinuity on the basis of test boring is considered to be an important task.

DISCONTINUITY SURVEY ON THE BASIS OF CORE DRILLING

Discontinuity survey on the basis of core drilling depends on the recovery of core. A full or almost full recovery of core during drilling is suitable only for determining the specific value of discontinuity faces.

For core materials of these drillings the specific length of core pieces greater than 5,o cm are considered as a parameter characterizing discontinuity. This is the so called discontinuity parameter /$t_{5,o}$/

$$t_{5,o} = \frac{\sum_{a}^{b} h_i}{h_b - h_a}$$

where - h_i length of cores longer than 5,o cm

h_a and h_b depth section relating to the beginning and end of the investigated section

Thus a value between 0 and 1 can be used for determining discontinuity and discontinuity of rock bodies can be characterized by this number. To take into account the discontinuity system of rock bodies it proved to be expedient to take the index of fissure $/t_r/$ calculated by using discontinuity parameter:

$$t_r = / 1 - t_{5,o} / 100$$

when rock bodies with few joint faces are characterized by a value of t_r lower than 10% and rock bodies crossed with intensively cracked and densely joint faces are characterized by a value of t_r near to 100%.

The index of fissure can be made proportionate with the number of joint faces in rock bodies. In similar way the specific number of joint faces /r/ can be determined too during elaborating core material .

$$r = \frac{\sum_a^b r_i}{h_b - h_a}$$

where - r_i number of joint faces
h_a and h_b depth section relating to the beginning and to the end of the investigated section

With core sampling every parameter of discontinuity or discontinuity system can be taken up only by the means of directional drilling and directional sampling, since data for dip and the line of dip of joint faces can be determined only by drillings carried out by the the means of such technology. Elaboration of core drilling materials can be completed easily by the means of in situ investigation methods which can be performed in drill holes and by the means of measurement results of which the properties of rock bodies can be determined.

To determine water permeability of rock bodies the joint evaluation of the index of fissure characterizing discontinuity system and the results of water saturation investigation is needed.

Drilling sections obtained when plotting the results of local water saturation experiments and elaborating the core material of test holes performed for discovering water permeability properties of rock masses under the circular river-closure dike in andesite at the construction of the Nagymaros Barrage presented typical cases. Drilling was performed in andesite rock masses.

Drilling section N° 9o27 /fig.2/ represents a rock body having a discontinuity rate of $t_m < 10\ m^{-1}$ and an index of fissure of $t_r < 20\%$. Cracks are closed, water motion along joint faces is small, water saturation experiments showed a small quantity of saturated absorbed water along the whole drilling section.

In the rock body crossed by the drilling N^o 9o63 /fig.3/ the specific value of discontinuity surfaces is $t_m > 50\ m^{-1}$ and the index of fissure is $t_r > 75\%$. High values of absorbed water quantities suggest intensive water motion along joint faces.

The core section on the drilling section N^o 9o55 /fig.4/ where the index of fissure is equal to $t_r = 100\%$ causing the especially high water saturation value is indicated by an arrow.

CORRELATION BETWEEN DISCONTINUITY SYSTEM AND WATER MOTION MODELLING

The survey of discontinuity systems in values is suitable to replace the discontinuity of rock bodies with hydrodynamic-mathematic models in order to analyse water motion along discontinuity after having made it suitable for engineering practice.

The principle of the model is based on the property of the discontinuity system, i.e. on the fact that the water carrying medium branches off in a random way and the thin rivulets flowing and separated in it join again mixing in different measure. The elemental volumes of rock bodies can be covered with a framework by the means of two systems of networks perpendicular to each other and fitting at the nodes. The network consist of pipes simulating discontinuity. The cells of the pipe-network correspond to the rock blocks constituting rock bodies. It can be supposed that pipes represent actual motion retardation i.e. the route of water.

Kovács /1981/ proved that constructing such a model the route on the two planes are considered as continuing one another and so the section perpendicular to one another can be turned into one single plane. Figure 5 shows the sheme of the framework of the regular networks suggested by him.

Period during which a water particle passes through a pipe section of given length /a/ is typical of the system. The necessary time /t/ for passing through a section L depends /apart from period t/ on the number of nodes. In the case of simple diagonal quadratic net it is:

$$L = n \cdot a$$

In the chosen model the relation between petrophysical characteristics of rock bodies and the material-constans of the model should be determined by the means of laboratory measurements. The chosen pipe diameter and the roughness properties of the inner wall of the pipe are thought of.

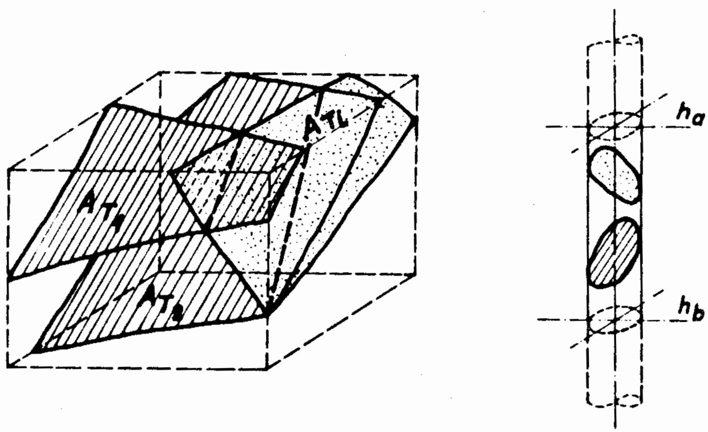
Having these conditions it can be obtained, that the geometrical size of the network model simulates the actual discontinuity system. The pipe elements simulate water motion between intersections. The full model simulates water motion with intersections. Elaboration of core materials of test holes by the presented method allows to chose from the investigated rock mass the identical rock bodies from the point of view of hydrogeology by using the index of fissure /t_r/. Geometrical size of the rock body and the measured number and direction of joint faces ensure determination of the measure of discontinuity /t_m/. Thus this method serves as a basis for modelling water motion in rock bodies with discontinuity as well.

REFERENCES

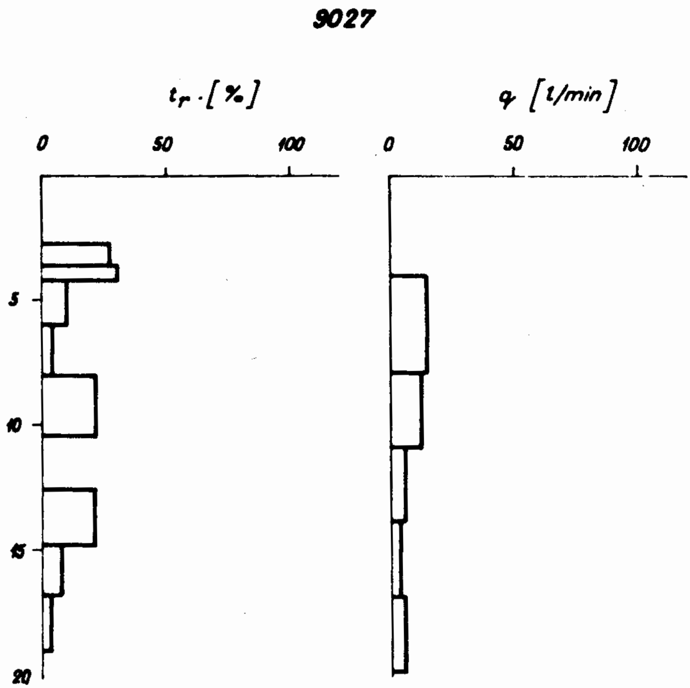
[1] Asszonyi Cs. - Gálos M. - Kertész P. - Richter R. A kőzetmechanika anyagszerkezeti és reológiai alapjai. Material structural and rheological fundamental principles of rock mechanics. VEAB, Veszprém, p. 446. /198o/

[2] Kovács Gy. Az időben változó szennyezés porózus közegben való terjedésének vizsgálata. Spreading of time-variable pollution in porous media. Hidrológiai Közlöny, Vol.61. No. 1. pp:1-6 /1981/

FIGURES

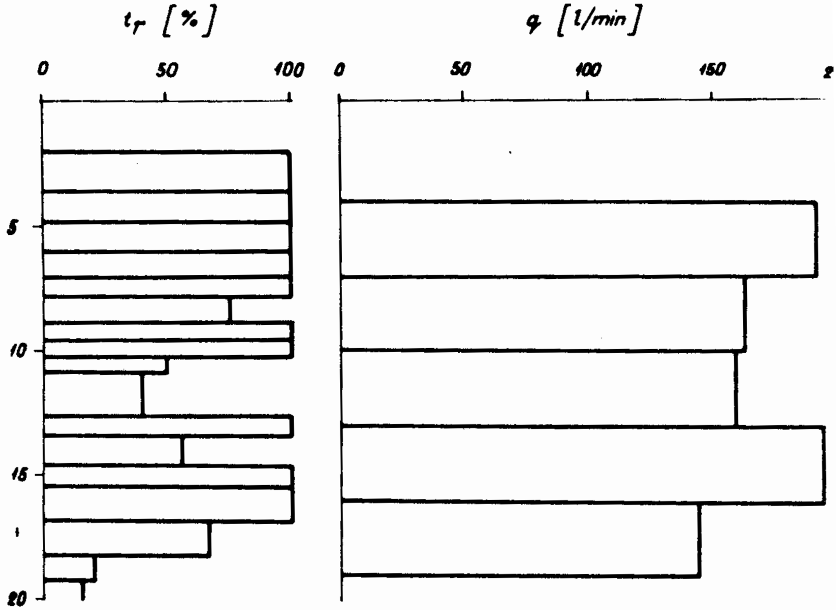


1. ábra Fig. 1

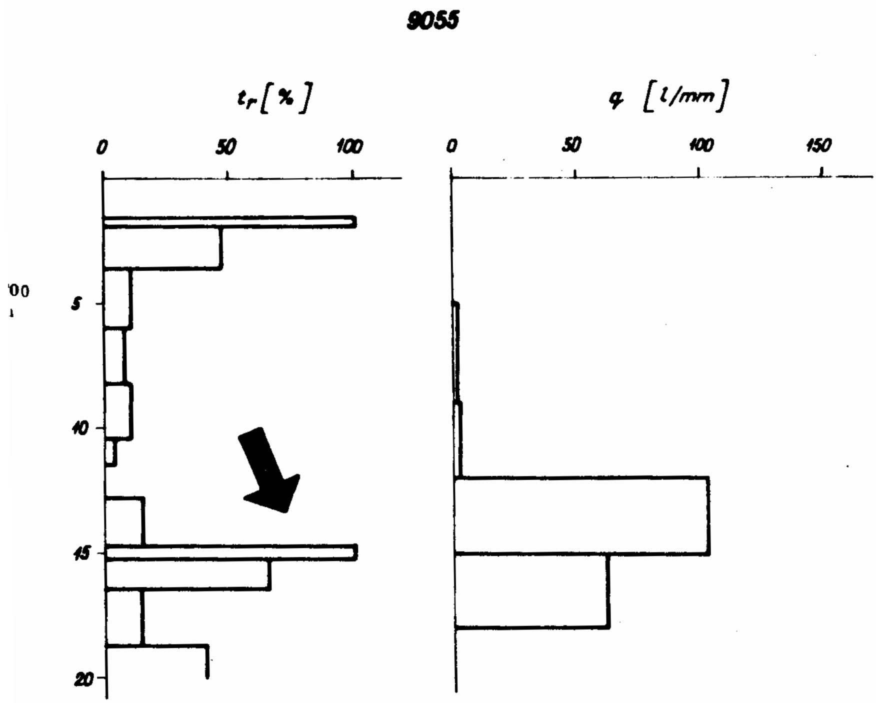


2. ábra Fig. 2

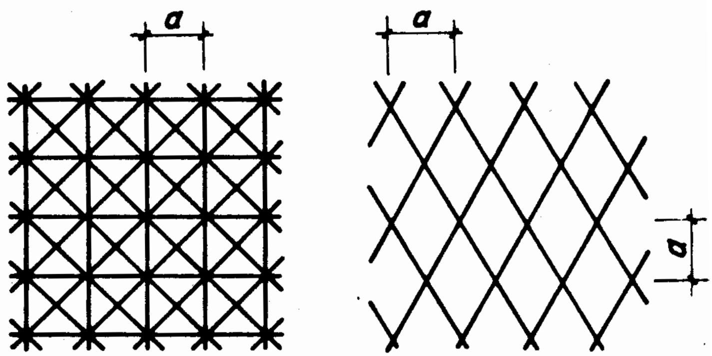
9063



3.ábra Fig. 3



4. ábra Fig. 4



5. ábra Fig. 5