Miskolci Egyetem
(University of Miskolc)
Műszaki Földtudományi Kar
(Faculty of Earth Science & Engineering)
Mikoviny Sámuel Földtudományi Doktori Iskola
(Mikoviny Sámuel Doctoral School for Earth Science)

Director of the Doctoral Academy
Dr. h.c. mult. Dr. Ferenc Kovács, professor
full member of MTA *(Hungarian Academy)*

EFFECT OF COMPRESSION WAVES ON THE STATE OF THE BRANCH ROADS

Themata of Ph.D. Thesis

Written by:

Tamás Havelda
Dipl. Mining Engineer
Dipl. Leader of Marketign

Director of Studies: professor Dr. Zsolt Somosvári
Professor of Engineering

Miskolc, 2004.

I. ANTECEDENTS, AIMS

In Hungary, structure of industry has significantly changed after changing in the political system. It is especially true for mining industry and even more for deep mining. The whole bulk of mining has had to take retrogression, although it is reassuring that change of structure can be observed, the emphasis tends to transpose from deep mining to surface mining.

Times are hard for deep mining due its material demand and its demand for live labour – so being more expensive from the aspect of specific costs. The above-mentioned facts are especially true in the power generation sector. There is a significant oversupply in the electricity market, and partial and complete opening of the market has to be taken into account, so specially sharp competitive environment can develop.

At power generation applying coal, cost of the fuel amounts to more then 70% of the gross expenditure. Consequently, reduction of this cost will have the highest effect on the price of the produced electricity. Cost components of deep mining, handicapped due to natural capabilities anyhow, have to be kept on split and analysed for reduction of costs.

Within the material cost, cost of material for road support can be considered as such a cost component. It is especially true for mining plants winning one-slice thin, and medium thick deposits, such as Márkushegy Mine Site. (Annually, a cost amounting to more than HUF 400 million is affected.)

During series of years in the mining practice, what safety devices are used for road supports has developed per areas and plants. This developed depending on the depth, the stone, and pressure conditions, and on the expected lifetime of the tunnels, however, calculations only rarely backed it up. In several cases, “remembrance of the experienced overman” determined whether the tunnel had “stood” at the mentioned area 5 or 10 years before; what safety structure and spacing had been necessary for the tunnel to be won; or, by chance, whether the location or the route of the tunnel had not had to be modified. Theoretical calculations existed, however, conclusions basing on measurements are so much the less.

As aims, we can put the following questions:

- Is the installed supporting force enough?
- Will not it lead to its too early destruction?
- When will tunnel retimbering become necessary?
- Has not the tunnel over-supported?
- At all, what supporting structure to chose for the given conditions?

Have not been superfluous structures built-in, so have not been cost spent on it, higher than required? Likewise, it will cost additional costs if supporting elements more or less than necessary are installed in the tunnel, and therefore, later repair and re-structure will be needed.

The aim of the thesis to elaborate a method of measurement applying new and up-to-date devices, which is suitable for and helps expert with answering the above – mentioned questions.

For this purpose – by my direction – a research was carried out at Márkushegy Mine Site.

Márkushegy Mine Site of Vértesi Erőmű Rt. *('Vértes Power Plant Ltd.)* is the country's largest deep mining plant. Through realisation of RETROFIT-programme admitted in 2004 (project for environmental protection, flue gas desulphurisation and for increasing efficiency), long-term power production, and collaterally with it, coal production will be possible.

Connecting a field to the production, concentration of extraction, technical developments, increasing of the productivity of the deposit by modification of the extraction sizes, rationalisation of the human resources and other measures serve to reduce specific costs, so the improvement of competitiveness of the company.
I carried out this research in mining branch road with open curved gate, in retreating mining, with Eocene stone conditions.

II. RESEARCH METHOD

As a line of principle, I determined that load influencing the tunnels (supports) has to be measured by means of suitable measuring devices, at several places and for a long period.
I selected three measuring points and measuring ways, for continuous observation at the same extraction area.

1) at the road
2) at the breast of work,
3) in the hole.

will provide direct information on the weight bearing capability of the installed supporting structures, as in this case the load is determined not on the basis of reasoning, but based on primary measurements. This method implies original elements concerning this topic.

In frame of researching and developing work, a reception frame of individual design was fabricated and installed, the assembly drawing of which can be seen in *Figure 1*. After it had been installed, this was suitable for load indication.

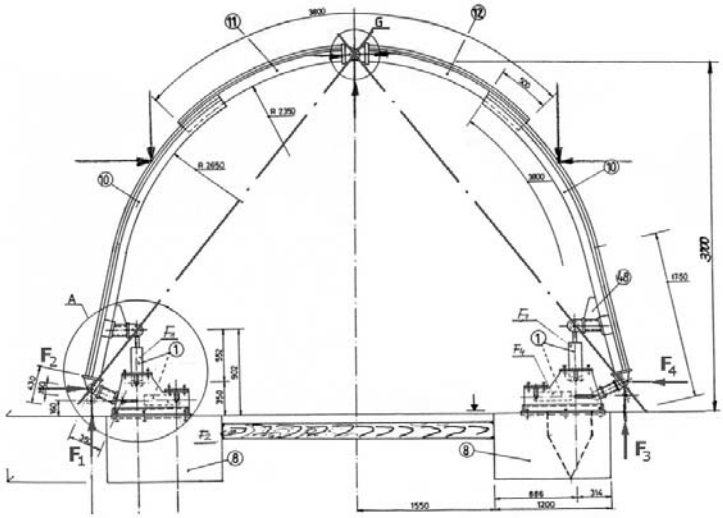

Figure 1

Pending processing measuring data, I checked the dynamical balance of the frame. However, no data on opposition against the deformation of the material of the base were available for calculating the quantity of single

forces transferred from the base. In order to gain these data, on-site measurement was carried out.
The sketch of the road support (TH arch) is shown in *Figure 2.*

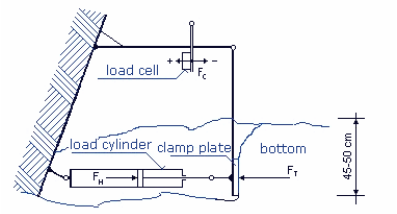

Figure 2

Measurement at Breast of Work

is well known in the literature, however, in order to draw conclusions, this method was needed, as loads caused by extraction and affecting the road will significantly influence the destruction and stability of the tunnels. *(Figure 3)*

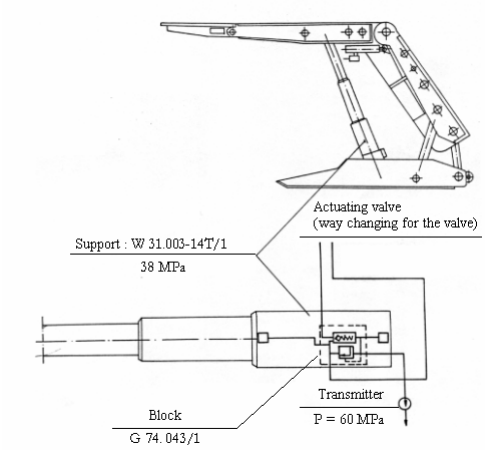

Figure 3

can provide information about the destruction of block of rock. From this, we can draw conclusions how the compressive waves caused by the winning process run down in space and time and how big the load-bearing capability of the working area is. Since extraction drifts will be won in this block, interrelations can be found between the stability of the tunnel and the weights. (*Figure 4*)

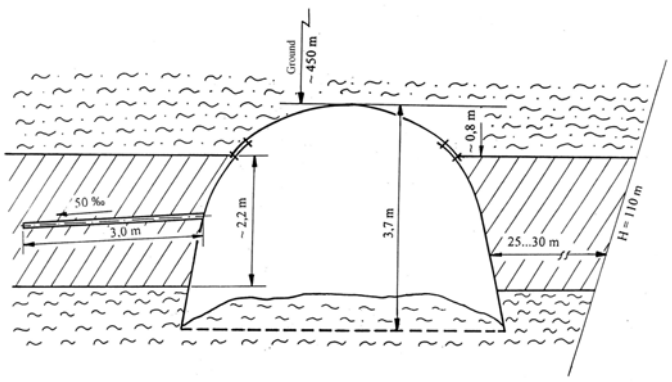

Figure 4

Matching these three measuring points, I elaborated the plan of the measurement, as well as I planned the locations of the installations.

At constructing the measuring system, it was practical to deduce the occurring weights to volumetric manometry, in a uniform manner. Matching to this, a measuring data collection system was developed, the construction of which can be seen in *Figure 5*.

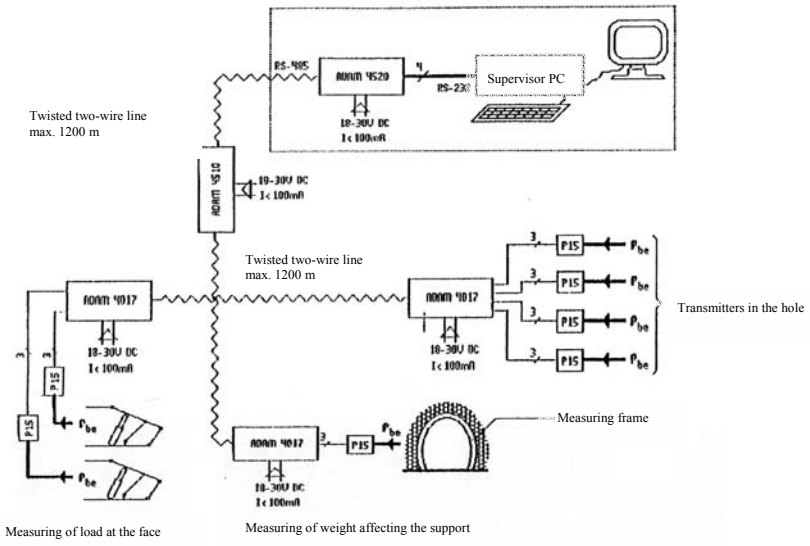

Figure 5

Supervision and data recording of the system was provided by an IBP PC, the tasks of which were as follows:

- direction of information transmission via channels of RS-232-es;
- continuous data display;
- data recording, both in printed and magnetic form .

The data collection system was built on data collecting modules of serial 4000 named ADAM fabricated by ADVANTECH. All of the modules contained one intelligent microcontroller each.

The applied pressure transmitters were of Hottinger Baldwin types.

Signals provided by the pressure transmitters were digitised by a signal-processing unit placed near them, and this unit transmitted them to the supervisor and data collecting PC, via a twisted two-wire line. According to the concept, a data-collecting module of ADAM 4017 type performed this work at the three measuring points each.

III. THEMATA OF THE THESIS AND ITS NEW RESULTS

Calculation based design procedure for road supports are already known. However, it is common in the mining practice that way of safety road supporting is determined based on the experts' experience.

1. The new method is suitable for determining value and run-down in space and time of the compression waves caused by extractions under actual mining conditions.

2. During the researching work, I completed the new method applied for measurements in the tunnel with methods already known earlier, so with measurements performed at breast of work and in the hole.

3. My research method made the comparison of several kinds of measuring procedures carried out at several places underground by applying identical principles adoptable, by the fact that I deduced weights measured at different places to measuring pressure in a uniform way. The measurements were carried out simultaneously, however, independently from each other. Processing and analysis were executed by means of an identical system, controlled by PC.

4. The reception frame designed for the research and presented in this thesis verified that it is adaptable for measuring weight affecting the road support. Based on the measurements performed by means of this, weight overtaken by the road support can be stated based on good approximation.
   Therefore, selection of structure of adoptable load bearing capability and with proper way of installation will be possible, so that later on, this support cannot damage too early due to weights affecting it, or the destruction will be of such extent that the tunnel should not loose its original function. Also, number of bonding units necessarily clamping TH arches – aligning with the weight- can be determined.

5. Position and extent of the transmitted compression wave passing in front of the breast of work can be determined by means of data provided by the mentioned reception frame, in function of the distance. At the same time, it can mean some help for determination of the dimension of the inbye rib to be allocated between the operating longwall face and the underground object to be protected (e.g. a main drive). It has to be emphasized that in this thesis a method bas-

ing on measurements (under given stone conditions) was stated.

6. By installing a measuring device of own design, degree of bottom yield of tunnels with clearance become measurable. Bottom yields can show extreme degrees under different stone conditions, which has to be born by the road support. It has established that a closed road support can only adopt opposition of certain extent (so can hold a certain extent of weight) against the effect of bottom yield, so raison d'ętre of application of open road supports cannot be queried. The only matter is that load should be measurable, and owing to it, bottom taking should be designable. By means of this, bottom yields considered as “damaging” can be revaluated through my researches, so a guideline can be received for modifying technology of bottom taking.

7. At the breast of work, extent of so-called transmitted load could be measured and determined, based on the research carried out in the moving shields, so from measuring weights affecting supporting units of the extraction, that have to be born by branch roads of the extraction without any deterioration. Procedure I elaborated is adoptable for determining the distance of a producing longwall stope from a given underground object to be protected.

IV. UTILIZATION OF THE RESULTS IN PRACTICE

1. The new research method that has been presented, and its outcome can be applied also in other ground or plant of mines.

   - the necessary road support can be determined based on the measurements, so additional costs arising from over- and under supporting of the tunnel can be avoided;

   - technology and rate of bottom taking a road with clearance will become designable;

   - it will be possible to determine the size of the underground inbye rib;

   - While specification issued by ÁBBSZ *('General Safety Code for Mining')* for winning road supports can only define the parameters of the supporting structures to be installed experientially, the propounded method can determine the necessary support by means of concrete calculations.

2. Researches conducted at Kőhalmi ground of mine of Márkushegy Mine Site made significant cutbacks possible.

   - Out of the three "U"-type pairs of bolt used for bonding lateral and head arches, one pair can be neglected.

- Installation space of “TH” structures can be increased from 60 cm to 80 cm, which means 25 % saving on material costs.

- Technology and rate of bottom taking was modified. So, also the yielded bottom can contribute to counterbalancing cross-stream forces affecting the road.

- Results of the research proved that compression wave in front of the face of stope would appear at a relatively constant distance, and the extent of this was not considerable after a distance of 70 m. Based on this, locations of the pillars for the mine roadways to be protected can be allocated safely.

V. LIST OF PUBLICATIONS ON THE TOPIC

[1] **Tamás Havelda** Széleshomlokú fejtések által keltett nyomáshullám hatása a kísérő vágatok állapotára, valamint a fejtés és a vágatbiztosítás terhelése a Márkushegyi bányában
(Effect of Compression Waves Caused by Longwall Face Mining on the State of Branch Roads. And Loading of Extraciton and Road Supports at Márkushegy Mine Site)
XXXIII. Bányagépészeti Konferencia kiadványa
Siófok, 2000. szeptember 14-15.
(Publication of Conference of Mine Engineering XXXIII,Siófok, 14th – 15th September 2000)

[2] **Tamás Havelda** Egy kísérlet folytatása vágatbiztosítás megfelelőségére.
(An Experiment on Adequacy of Road Supports)
XXXIV. Bányagépészeti Konferencia kiadványa
Siófok, 2001. szeptember 27-28.
(Publication of Conference of Mine Engineering XXXIV, ,Siófok, 14th – 15th September 2000)

[3] **T. Havelda –**I. Kardics

Márkushegyi Bányaüzem Kőhalmi bányamező első fejtése
(First Extraction at Kőhalmi Ground of Mine of Márkushegy Mine Site)
BKL 134. évf. 3. szám 126-129.o.
(BKL vol. 134 issue 3, pages 126 - 129)

[4] S. Szalkai –**T. Havelda** –I. Kardics

Az alsó (II) telepek művelésbe vonásának tapasztalatai a Márkushegyi Bányaüzemben

(Experiences on Connecting Bottom (II) Deposits to Mineworking at Márkushegy Mine Site)
BKL 132. évf. 4. szám 250-260. o.
(BKL vol. 134 issue 4, pages 250 -260)

[5] G. Ladányi – **T. Havelda**

Meassuring method for determining sock pressure in mine road ways. Mining Techniques 2001 International Conference, 2001. September 18-21. Krakow-Krynica, Proceeding of the conference, p. 218-224.
(Konferencia kiadvány)

[6] **Tamás Havelda** Nastepstwa odzialywania fal cisnienia wywolanycle przez wyrobiska scianowe na stan chodnikow przysxhianowych
Kontech Konferencia kiadványa XIX. előadás 2000. november 8. Szczyrk, Lengyelország