A strata control system and its application in West German coal mining

U. GROTOWSKY¹ and H. IRRESBERGER²

¹BAG Westfalia, West Germany
²Bergbau-Forschung, Essen, West Germany

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Summary

A strata control system has been developed to improve mine planning and design in deep coal mines in West Germany, where redistributed stresses from longwall workings in weak strata create difficult support problems. The system involves theoretical, laboratory and underground observations and studies of strata and support performance. Examples of the system covered in detail include planning the position and support of a cross-cut; improving a face layout; planning a gateroad; planning strata bolting and planning longwall face layouts.

Keywords: Coal mining; strata control; rock pressure; mine planning; longwall mining.

Introduction

In the last few decades, coal mining in West Germany has been steadily advancing into deeper levels at about 10 m per year so that the average working depth (Fig. 1) is now about 900 m. Some of the collieries are already extracting at 1400 m; pressure from the overlying strata necessarily increases as mining goes deeper.

The Carboniferous is characterized by alternating coal seams, soft clay shale beds, slightly firmer sandy shale and strong sandstone. Tectonic disturbance is extreme.

In West Germany, coal mining is exclusively by longwall extraction of wide areas which causes appreciable pressure redistributions in the soft strata. Output per face has risen in the past (Fig. 2), due chiefly to the use of high-performance winning and conveying machinery as well as robust face support capable of carrying extreme load.

The combination of increasing working depth and intensive concentration of workings has forced German mining engineers to take a close and systematic look at rock pressure and its effects. The purpose-related application of this highly refined examination technique and the results obtained from it have come to be known as the strata control system (Jacobi et al., 1981; Grotowsky, 1982). The way in which the system functions is best described by two control loops.
Fig. 1. Average working depth in West German coal mining.

Fig. 2. Average output per production face and face output per manshift (OMS) in West German coal mining.

(Fig. 3). Both these loops are based on results analysis. One loop completes and improves on the prediction and planning operation, whilst the other is concerned with the supports and methods directly involved in strata control. Both loops are realized by means of simple facilities suitable for the coal deposits and for mining operations.

With the developments which have taken place in mining technology over the last few decades, the rock mechanics aspect of coal mining in the Ruhr have become particularly important for the following reasons.

1. Mechanization and concentration of workings have both increased. This has raised the capital investment and labour involved in equipping production faces so that, for cost reasons, a uniform level of production must be attained. This can be placed at hazard by unforeseen rock pressure effects.

2. Repairs to supports and machinery are becoming more complicated and call for special skills. Not only is it difficult to find suitably skilled staff; the purely manual aspect of the job has become particularly expensive so that repairs must, as far as possible, be avoided.

3. The measures adopted for strata control are adapted to operational conditions in both the research and development stages and are similarly differentiated so that they can be selected as and where appropriate and their effect can be largely predicted.

4. Each year, 50 km$^2$ of roof surface is exposed in production faces in West German coal mining: these areas are briefly supported, and then caved or, to a lesser extent, allowed to settle on solid stowage. Despite modern shield and chock-shield supports, an average 16% of the exposed roof still falls in. A poorly controlled roof adds a great deal to operating costs.

5. Each year, more than 500 km of gateroads are driven in West German coal mining, and these are supported and held open during the life of the face. Although 90% of all gateroads are supported with modern yielding arches, on average they undergo closure to a third of their original height. This causes interruptions in conveying, transport, manriding and ventilation. In places where these stoppages and interruptions are unacceptable the roadways have to be dinted or repaired. All this imposes extra cost.