

## SESSION 20: UNDERGROUND WORK

### Papers:

GEOTECHNICAL MEASUREMENTS AND ANALYSES OF OPEN STOPING OPERATIONS AT WARREGO MINE  
G. Worotnicki, M.B. Wold and R.J. Walton, Vol 2, 169-176

THE PERFORMANCE OF DISC CUTTERS IN SIMULATED JOINTED ROCK  
D.F. Howarth, Vol 2, 177-182

GEOMETRIC DESIGN OF UNDERGROUND OPENINGS FOR HIGH HORIZONTAL STRESS FIELDS  
P.J.N. Pells, Vol 2, 183-186

### Paper by D.F. Howarth

Mr W.E. Bamford commented that the effect of joint spacing as a variable did not appear to have been given very much discussion and asked whether the authors could elaborate. Mr Howarth agreed that joint spacing was not given much discussion but that it was undoubtedly an important parameter. Mr Bamford further commented that the mode of failure under disc cutters in the field was quite different from that shown in the slides. Boring perpendicular to strike did agree with the second paragraph in the paper, but boring parallel to strike was often just as difficult as in unjointed rock. This was due to the observed field mode, tensile failure parallel to the tunnel face, not to shear chipping as in the lab tests.

Mr Howarth replied that at certain disc separation and depth of penetration, failure did not occur. In his work he was looking at the effect of jointed rock variables on individual single cuts.

Mr H. Bock suggested that, in cutting rock samples along straight lines instead of circular ones, the author might be neglecting an important parameter. Mr Howarth replied that the difference between linear and circular cutting was in the lateral forces on the cutter. These forces were small in the large diameter full face tunnelling machines.

### Paper by P.J.N. Pells

Prof Endersbee commented that the normal behaviour of underground excavations in horizontally bedded sedimentary strata was for the roof to break to a flat crown. This was of course the usual condition observed in coal mines, and rectangular openings were used. In the case of the Drakensberg pumped storage power plant, the rock conditions were remarkably similar to Poatina, and a similar roof design was used. The excavation control at Drakensberg was exceptionally well done, and there was no sign of rock loosening even at re-entrant corners on the walls of the main cavern. The final floor level was pre-bolted by installing grouted anchor bars before the final bench blast. This provided a competent floor where otherwise a badly fractured floor would have resulted.

Mr Worotnicki questioned the use of a low shear modulus for failure in bedding planes caused by low cohesion. Mr Pells replied that designers tended to use elasticity loosely and that the effective behaviour of the material around the opening was that of a low shear modulus.

Mr T.A.H. Dodd asked how, with the 'silo' design of an underground powerhouse, sufficient headroom was obtained in the control chamber to permit installation and maintenance of the large machines involved. Mr Pells replied that there was sufficient room. Prof. Endersbee commented that this was an economic use of space tried in USA.

Mr S. Guidici commented that the ubiquitous value of  $\sigma_h/\sigma_v = 2$  was also true of the Gordon underground power station in quartzite and schists, and asked whether the author had any information on the deformation patterns for the 'elasticity' model used. Mr Pells replied that he had no such information since he had been looking at the problem from the point of view of stress concentrations.