# Safety In Mines Research Advisory Committee
# Project Summary: GAP 606

| Project Title: | Support technologies to cater for rockbursts and falls of ground in the immediate face area | | |
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| **Report Date:** | 31/03/2000 | **Related Projects:** | GAP032, GAP330, GAP335, GAP627 |
| **Category:** | Gold and Platinum | Stope Support Research | Rock Engineering |


## Summary

The aim of this project is to investigate temporary and face area support systems (with special reference to the use of tendon support). Improved face area support design methodologies are proposed, and a probability analysis is conducted to investigate excavation stability and the requirements of a temporary support system.

It is found that tendons are currently only used under quasi-static conditions. Typically tendons are used in shallow mines and to depths of 1 600 m below surface in situations where the UCS of the hangingwall rock exceeds 170 MPa. Tendons have been successfully used in stoping widths as low as 0,9 m. The use of tendons is primarily based on the presence of at least one pronounced hangingwall parting at a reasonable distance (0,2 to 3 m) from the reef – hangingwall contact (see Figure 1).

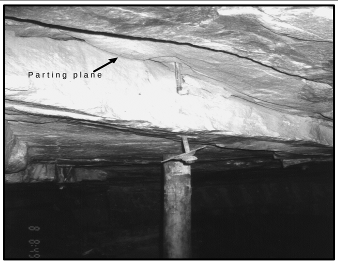


***Figure 1 Hangingwall layering suitable for rockbolting (Kinross Mine). Note bearing plate loosened during blast.***

A detailed investigation into strata conditions, which are most suitable for particular face area support systems, was conducted. The use of tendons is generally recommended for strata conditions entailing a strong hangingwall, minimum hangingwall fracturing, but with problematic roof parallel discontinuities. In other strata conditions appropriate columnar support types with adequate areal coverage are recommended. In conditions of weak and fractured hangingwalls, high levels of areal coverage are required. A major output of the investigation is in the form of tables giving recommended support types for various rock classes in shallow and intermediate/deep mining environments.

Underground investigations, as well as analytical and numerical models, resulted in an improved understanding of tendon interaction with a discontinuous hangingwall in quasi-static and dynamic conditions.

An engineering approach for the design of stope face support systems is proposed and facilitates the convenient evaluation of support resistance, energy absorption and spacing requirements of tendons, props and packs in the stope face area.

Consultations with production personnel led to insights into operational constraints of temporary and face area support systems. Specific constraints investigated include labour availability, time, availability of support units, transport and storage, stope width, dip of reef, effect of mine geometry, and position of marked shot holes. Various solutions to overcome the operational constraints are proposed.

The SDA II software (support design tool) was used to investigate periods in the production cycle when face area support systems are least able to meet their performance requirements. It was found that the shift, which normally enters the panel after the blast, is most vulnerable. To improve worker safety at the face, it is essential to reduce the unsupported hangingwall span before the workers enter the panel after the blast. In certain circumstances tendons are effective in meeting this requirement. Spray-on membrane support could also potentially provide this support in highly fractured conditions but the effectiveness and practicability of this type of support has yet to be evaluated in the aggressive face area environment. Practical constraints (appear to) militate against the use of coal mining type shield support in the face area of deep, narrow stoping width gold mine stopes mined by blasting.

A probabilistic study was conducted to quantify the risks of injury, depending on the type of support, condition of the rock, mechanisms of deformation of the rock and support, support installation constraints and personnel exposure. A methodology was formulated to determine the risks of injury associated with various support types recommended as optimal for representative classes of strata conditions. Detailed guidelines for applying the methodology and recommendations on the verification, calibration and expansion of the methodology are given in conclusion.

## Conclusions

- Tendons, as they are being used currently, provide benefits which include ease of integration with other support types; minimal congestion at the immediate face area; ease of cleaning of the face and reduced risk of rockfalls in the face area during cleaning, provided that attention is given to their installation, tensioning and spacing. Their use is generally recommended for strata conditions entailing a strong hangingwall, minimum hangingwall fracturing, but with problematic roof parallel discontinuities.
- The hangingwall rock mass typically has a complex, variable nature resulting in varying degrees of discontinuity and hence changes in strata conditions. The experience and knowledge of rock mechanics practitioners is an important and essential input in determining the nature of the parameters influencing strata conditions.
- Support systems such as the twin beam, the safety net, and large headboards are suitable and practical to reduce the rock related hazards at the stope face. Other technologies (e.g. powered support, shields) have the potential to significantly increase worker safety, however, at this stage their application in narrow, tabular hard rock stoping environment requires further research endeavours.
- The proposed engineering approach for the design of stope face support systems is a convenient method to estimate support resistance, energy absorption and spacing requirements of support units such as tendons, props and packs.
- Further operational aspects of support practices, such as flexibility in the allocation of labour in panels; proper stope planning and layout; adequate material transport facilities in stopes; correct marking, drilling and blasting procedures; modification of the current cleaning method etc, should be given attention to ensure the successful implementation of support strategies.
- The rockfall and rockburst hazard is exacerbated as the distance from the stope face to the first row of support units is increased. Thus the shift, which enters the panel after the blast, is most vulnerable. To reduce the rock-related hazard, non-removable blast resistant face area support systems, which are pre-stressed and offer adequate areal coverage, are recommended. Under rockburst conditions, the ability of support units to yield in a controlled manner is important.
- The risk of injury depends on the type of support, condition of

*Audited by:*