The grouted skeleton pack

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SYNOPSIS

A new type of pack has been developed primarily for the support of narrow stopes. It was shown in the laboratory that it has characteristics that very closely approximate the optimum required by underground support to achieve hangingwall stability.

SAMEVATTING

Daar is 'n nuwe tipe pak ontwikkel in die eerste plek vir die stutting van nou afbouplekke. Daar is in die laboratorium bewys dat die eienskappe daarvan baie na aan die optimum kom wat van ondergrondse stutting verwag word om dakstabiliteit te verkry.

Introduction

Conditions in a section of East Rand Proprietary Mines, Limited, were such that the grout-base pack[1] appeared to be the most suitable type of support, provided it could be adapted for use at a low stoping width and the timber components could be protected against decay. The grouted skeleton pack that evolved, not only satisfied these requirements, but showed characteristics superior to those of the standard sandwich pack.

Description

An exploded view of the grouted skeleton pack is shown in Fig. 1. The main components are as follows:

(1) 10 cm rise, 60 cm saligna chocks,
(2) a rectangular knitted polyethylene bag with a draw-string at the open end,
(3) a knitted polyethylene cover, and
(4) grout with a sand : cement ratio of 2:1.

To build the pack, the bag is rolled down and placed on the footwall, and a skeleton pack is built in the bag to within a few millimetres of the hangingwall. The cover is pulled over the top of the pack to overlap the timber members by approximately 15 cm, and the pack is wedged in the normal manner. The bag is then pulled up to overlap the cover, and the draw string is tightened. To prevent ballooning of the bag when the grout is being injected, another skeleton pack can be built around it, a suitable rope wound around it, or shuttering erected. To ensure that the bag is filled to the hangingwall, full use must be made of the dip of the excavation.

Laboratory Tests

Two 125 by 60 by 60 cm grouted skeleton packs were tested in a 1000 ton press at the C S I R. Fig. 2 shows the load–compression curves of the grouted skeleton packs and a 120 by 60 by 60 cm standard sandwich pack. The curves for the grouted skeleton pack show a difference in behaviour in the 25 to 45 cm convergence range, which can possibly be attributed to the method of construction rather than to the quality of the pack.

As shown by the graphs, the initial load-bearing and controlled yield characteristics are far superior to those of the sandwich pack. As the rigid core of the skeleton pack was in direct contact with the plattens, the pack was active almost immediately convergence took place, giving a high initial load with very little convergence. The timber in the pack acted, to a large degree, as reinforcing rather than in a load-bearing capacity. In this way, the fractured grout was contained to provide a satisfactory controlled yield.

Underground Trials

Owing to changing circumstances and a lack of cementation facilities, the grouted skeleton pack was not installed underground at East Rand Proprietary Mines, Limited, but a number were installed in one of the Group's chromium mines. There, 120 by 120 cm packs were installed in a narrow stope with a view to replacing the chromium drive pillars. These packs were filled with waste to reduce the quantity of grout used. Unfortunately, at this stage nothing can be reported on their performance.

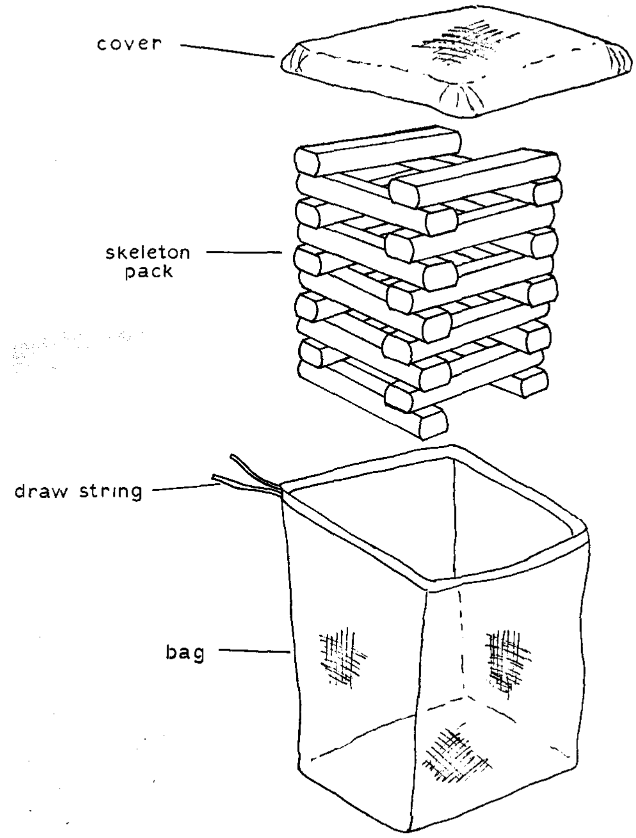

Fig. 1—An exploded view of the grouted skeleton pack

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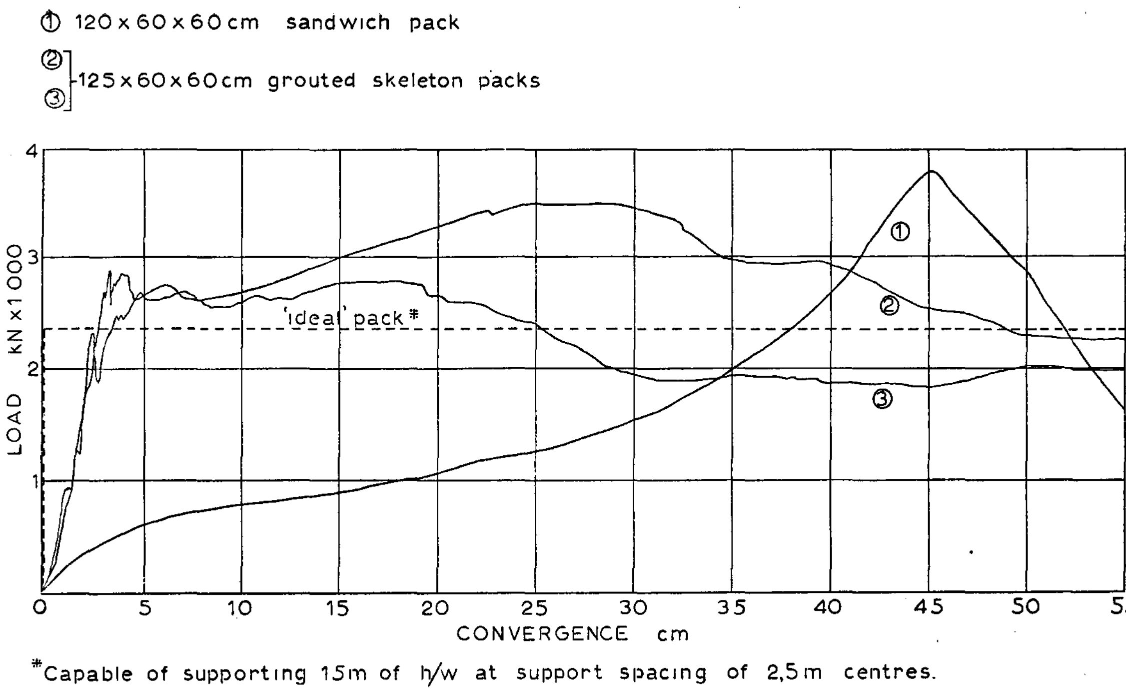

Fig. 2— Load-bearing and controlled yield characteristics

Conclusion

The characteristics of the grouted skeleton pack very closely approximate the optimum required by underground support to achieve hangingwall stability[2]. As with other types of support, the *in situ* performance of the grouted skeleton pack is unlikely to be equivalent to its laboratory performance. On the other hand, the grout is the main support component, and therefore loss of load due to creep, as experienced in other types of pack, should be at a minimum.

Acknowledgement

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References

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2. Cook, N. G. W., and Schuman, E. H. R. First report on the optimisation of underground support. Chamber of Mines of South Africa, *Research Report* no. 22/66. 1966.

Discussion of the previous paper

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At the platinum mines of Union Corporation Limited, support requirements are fairly stringent: the support should be stiff and strong and, even more important, should not get blasted out. It was with these requirements in mind that laboratory tests and underground trials were conducted with the mini grout-base pack or grouted skeleton pack.

Laboratory Tests

Grout-base packs can be built with the bag on the outside of the timber skeleton or on the inside, and will be referred to in this contribution as external or internal packs respectively.

Two sizes of packs, 60 cm square and 80 cm square, were tested. In all cases, the height of the pack, which included two layers of packmats, was limited to 1,2 m. Contrary to the E.R.P.M. experiments, the timber skeleton was reinforced by steel pins that had been inserted into holes drilled at the four corners of the timber skeleton.

The sand/cement ratios were varied between 5/1 and 3/1, and sufficient water was added to simulate pumpable mixes. A minimum curing period of 7 days was allowed.

Fig. 1 summarizes the load–compression results of the different packs. As the different sand/cement ratios used did not appear to have any effect on the strength and behaviour of the packs, only the average load–compression curve for each size and type of pack is included. It should be added that the scatter of the results was remarkably small: in the pre-failure stage there was hardly any scatter, and in the post-failure (yielding) stage the scatter was only about 50 tons.

A number of interesting factors emerged from the test programme.

(a) External packs were stronger, as well as stiffer, than internal packs, which is not completely unexpected in that the external packs were made up of con-

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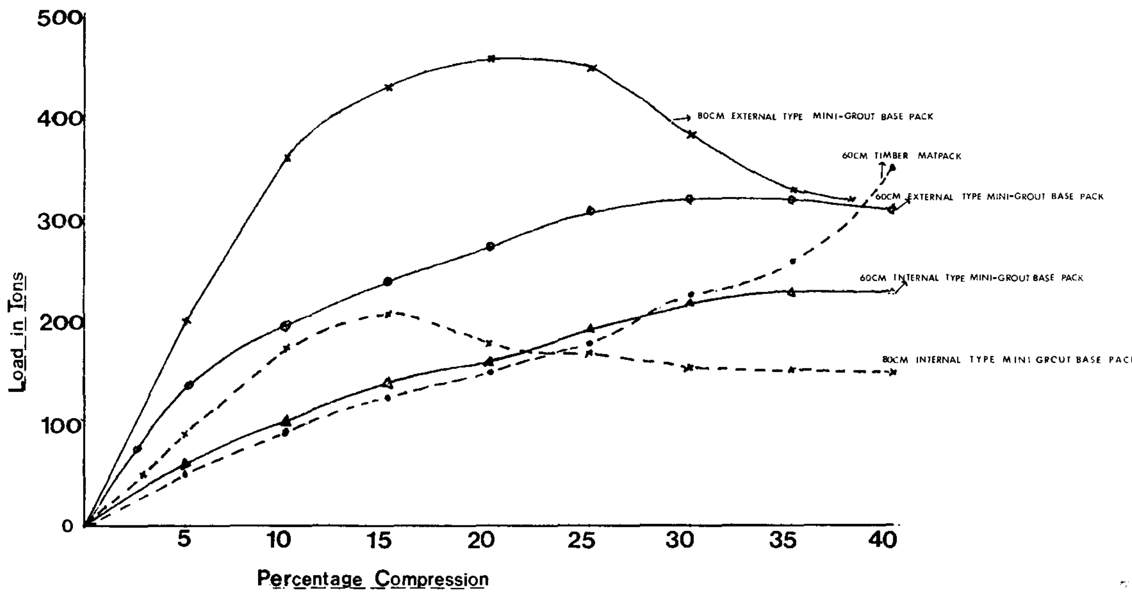

Fig. 1—Load-compression curves for mini grout-base packs

siderably larger volumes of concrete than the internal packs of similar dimensions. In addition, the chock pieces of the external packs were considerably reinforced, being completely encased in concrete.

(b) The internal 60 cm pack had a load-compression characteristic that is almost identical to that of a conventional 60 cm saligna matpack. This is no doubt due to the very small core of concrete available for supporting the load.

(c) Both 80 cm grout-base packs (external and internal types) were stiffer and stronger than their 60 cm counterparts up to their yield points. Beyond their yield points, both 80 cm packs exhibited distinct downward-sloping curves, during which stage the timbers were failing and the concrete was being crushed. The 60 cm packs did not exhibit this type of behaviour, and it can be surmised only that the smaller timber skeleton is stronger. At deformations of more than 25 per cent, the 80 cm internal pack was weaker than its 60 cm counterpart.

Underground Trials

Underground trials were conducted mainly to assess the blast resistance of the mini grout-base pack. At the platinum mines, blast damage to support occurs frequently, and the ideal support should be capable of resisting the force of the blast despite being installed close to the face.

A large number of 60 cm external packs were constructed at distances varying between 1 m and 3 m from the stope face. None of these packs was blasted out, and only in a few instances was the blocking on top of the pack damaged. Fig. 2 shows the condition of a pack after the blast.

A large number of packs were constructed in which the grout was pumped between 4 and 2 hours before the blast. Although no accelerator such as calcium chloride was added, the blast resistance of the pack remained excellent.

Fig. 2—The condition of a pack after the blast

Conclusions

The laboratory tests showed that the 60 cm external grout-base pack possesses all the properties required of support for conditions prevailing on the platinum mines of Union Corporation. The underground trials showed that blast does not damage the pack, even under the most adverse conditions of distance from the stope face and available curing time.