A simple device for the direct shear-strength testing of intact rock

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SYNOPSIS

A description is given of a simple, cheap device that enables the intact shear strength of rock to be determined quickly and inexpensively. Thin rock plates, prepared with a diamond saw, are tested in double shear by a linear punching action. By varying the direction of the diamond-saw cut in a number of specimens, the change in shear strength can be measured for different orientations relative to the rock fabric.

SAMEVATTING

'n Eenvoudige goedkoop apparaat word beskryf om die skuifsterkte van rotsmonsters vinnig en maklik te bepaal. Dun rotsskyfies word deur middel van 'n diamantsaag uitgesaag en word dan in die apparaat met 'n dubbel skuifponsaksie getoets. Deur rotsskyfies met verskillende oriëntasies te gebruik, kan die verandering in skuifsterkte relatief tot die gelaagheid van rotsmateriaal bepaal word.

Introduction

In assessments of the stability of excavations in rock it is sometimes necessary to obtain a measure of the shear strength of intact rock. A conventional shear-box type of testing machine is usually unsuitable owing to the high strength of rock and the problem of minimizing bending stresses on the rock specimen. These problems are largely overcome by the double shearing action of a device operating on the punch principle. This approach is not new, being described briefly in standard texts on rock mechanics, e.g. Vutukuri *et al.*[1]. However, it does not appear to be widely used.

Everling[2] has shown theoretically that the stress distribution across the shear surfaces is non-uniform. He states that the load at failure must consequently be lower than in a uniform shear–stress distribution, and that the shear strength will depend on the size of the test piece. However, from a series of practical tests, Maurer[3] found that the shear strength was independent of specimen thickness. Apparently localized failure and plastic deformation tended to equalize the shear stresses along the failure plane. The method therefore appears to be practical and adequate for engineering purposes.

This note deals with a device that has been applied successfully to a number of rocks of different types.

Description of the Device

The device operates on the linear punch principle as described by Maurer[3]. However, as shown in Fig. 1, it is in a very simple form in that only shear stresses are applied. No normal stress is imposed on the shear surfaces.

The device consists of three strips of hardened steel, two of which form the base on which the rock specimen is supported. The third forms the punch that passes between the two base supports with a clearance of approximately 0,3 mm. Commercially available tool steel stock was used for the bulk of the device, resulting in a very inexpensive item of equipment.

Configuration of Rock Specimen

For testing in the device, rock specimens are cut from cores or hand samples with a diamond saw. These specimens have the form of thin plates approximately 5 mm to 10 mm thick. This simple method of specimen preparation allows the 'plates' to be cut at specific orientations to the rock fabric. Consequently, it is very easy to measure the variation in shear strength with different orientation in the rock. This may be required, for example, in the case of sedimentary rocks in which the shear strength varies with inclination to the bedding direction. Simple jigs are used to assist in the cutting of rock discs from cores at different orientations to the core axis.

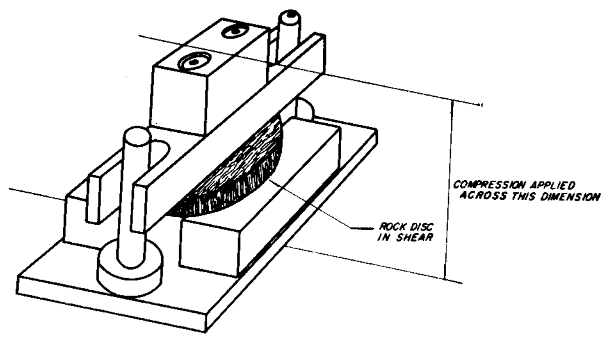

Fig. 1—Shear test device

Operation of the Device

The operation of the device is straight forward. The rock-disc specimens are placed in the shear device, as shown in Fig. 1, so that the required plane of shearing is parallel to the long axis of the device. The assembly is then placed in a conventional compression-testing machine. The compression loading of the device induces a double shear failure in the rock disc. The typical form of the failure is shown in Fig. 2. The force registered by the compression machine corresponds to the force required to shear the sample. The shear strength is calculated by dividing this force by the area through which shearing takes place.

An Application of the Device

Some results of an application of the device are shown as an example in Fig. 3. This diagram presents a plot of

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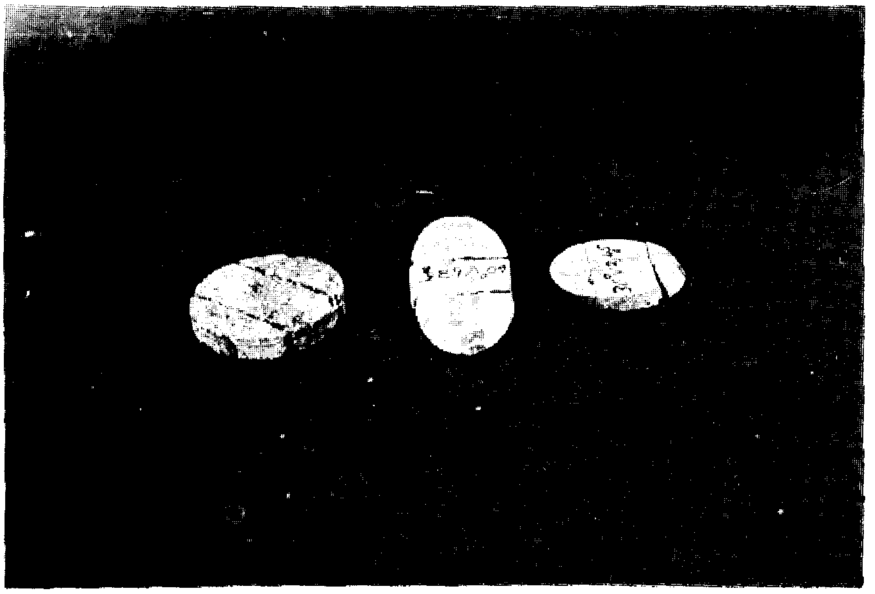

Fig. 2—Typical form of shear failure

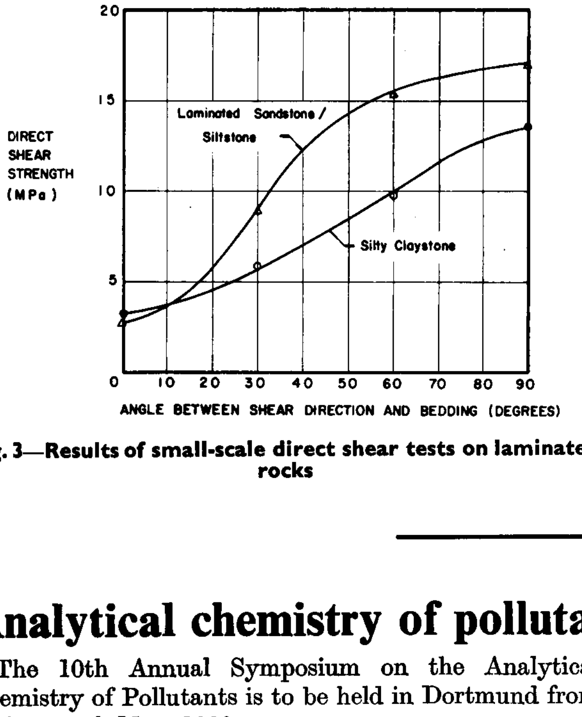

Fig. 3—Results of small-scale direct shear tests on laminated rocks

shear strength as a function of inclination to the bedding direction for laminated material taken from the immediate roof locations of two coal-mine prospects. Each point on these curves is the average strength determined from four tests. This diagram indicates the regularity of the results that can be obtained.

The simplicity of the device, and the rapidity with which specimens can be prepared and tested, suggest that it could be used as a form of index test.

References

1. Vutukuri, V. S., Lama, R. D., and Saluja, S. S. *Handbook on mechanical properties of rocks*. Vol. 1, Trans Tech Publications, 1974.
2. Everling, G. Comments upon the definition of shear strength. *Int. J. Rock Mech. Min. Sci.*, vol. 1. 1964. pp. 145-154.
3. Maurer, W. C. Shear failure of rock under axial and hydrostatic pressure. *Proc. 1st Cong. Int. Soc. Rock Mech.*, Lisbon 1966, vol. 1, pp. 337-341.

Analytical chemistry of pollutants

The 10th Annual Symposium on the Analytical Chemistry of Pollutants is to be held in Dortmund from 28th to 30th May, 1980.

One day will be devoted to the problem of mutagenicity to create a forum of exchange of ideas and information between toxicologists, biologists, and analytical chemists. Representatives from government, industry, and university will also give an orientation and voice their opinion about the planned toxic substances control act of the Federal Republic of Germany. A day is set aside for the topic 'Analytical Chemistry and Air Chemistry'. The rest of the time will be divided between papers dealing with water pollution, investigation of biological material, and application of new techniques.

It is planned to publish proceedings after the symposium. An exhibition of instruments and literature is being organized.

Further details are available from Dr J. Wendenburg, Gesellschaft Deutscher Chemiker, P.O. Box 90 04 40, D-6000 Frankfurt am Main 90, West Germany.

As the number of users of ion chromatography in Europe is expanding rapidly, it seems necessary to establish a platform for exchange of experience on this new technique. Therefore a workshop will be held on 2nd and 3rd June, 1980, at the Netherlands Energy Research Foundation (Petten, The Netherlands), which is 300 km from Dortmund, where the 10th Annual Symposium on the Analytical Chemistry of Pollutants is scheduled.

Further information can be obtained from Dr J. Slanina, Workshop on Ion Chromatography, ECN, 1755 ZG Petten, The Netherlands.