This method is based on inducing an artificial condition of stress-relief in the rock with a saw cut and taking simultaneous measurements of the resulting deformation. This deformation is then reversed again by applying compensation pressure with suitable loading devices. As a rule, the stresses needing to be induced in this process are equivalent to the original stresses. Unlike test methods based purely on stress-relief, this method requires no knowledge of the elastic constants of the rock at the measuring point.

The compensation method with flat jacks was first used by MAYER et al. (1951) and later simplified and refined by ROCHA et al. (1966). Its principle and procedures are illustrated in Fig. 1. As the first step, measuring pins are cemented on the surface of the component in an appropriate arrangement on both sides of the planned cut. The distances between the pins are recorded by electric displacement sensors or set strain transducers (reading accuracy ± 1 µm).

Following the zero measurement, a slot normally measuring 400 mm wide and 5 mm high is cut with a diamond-tipped circular saw. A crescent-shaped hydraulic pressure cell is inserted exactly into the slot and connected with an hydraulic pump fitted to a precision manometer (class 1.0). Finally, the pressure cell is loaded until the relief-induced deformations are compensated.

The method has a number of advantages:

- It does not assume a linearly elastic rock
- It does not require knowledge of the rock's deformation characteristics
- The large test dimensions minimise the significance of rock inhomogeneities

This method fails, however, when confronted with tensile stresses. This rarely occurs in practice, however.

Geotechnisches Ingenieurbüro
Prof. Fecker & Partner GmbH
Am Reutgraben 9 Fon: ++7243/5983-7
D-76275 Ettlingen Fax: ++7243/5983-97

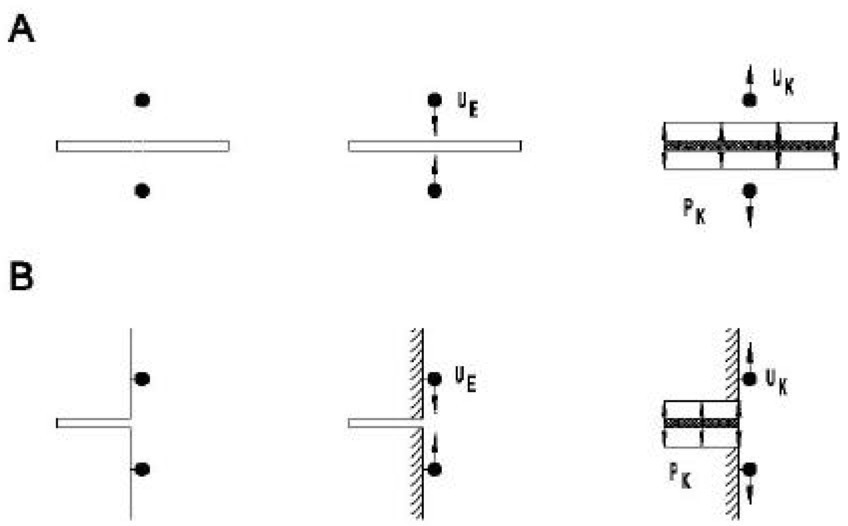

Fig. 1 Measuring principle compensation method
A = Front view, B = Cross section
U_E = relief-induced deformation
U_K = Compensation of relief-induced deformation
P_K = Compensation pressure

The evaluation of test results obtained by the compensation method with flat jacks is based on the following equation:

$$\sigma_n = p \cdot K_m \cdot K_a$$

p = Oil pressure in the cell at full compensation
K_m = Form constant of the pressure cell used
K_a = Ratio of cell area to cut area

The stresses determined with this equation correspond to the tangential stresses at a distance of 5 cm from the outer edge of the rock surface.

Geotechnisches Ingenieurbüro
Prof. Fecker & Partner GmbH
Am Reutgraben 9 Fon: ++7243/5983-7
D-76275 Ettlingen Fax: ++7243/5983-97

Assuming that displacement transducers are incorporated in the pressure cells or that the volume of hydraulic liquid injected to inflate the pressure cell can be measured to an accuracy of 1 cm^3, compensation tests with flat jacks may also be used to determine a rock's modulus of deformation. However, to comply with Recommendation No. 7 of Working Committee 19 - Rock Testing Technology - of the Deutsche Gesellschaft für Erd- und Grundbau e. V. (1984) and Suggested Method for Deformability Determination using a Large Flat jack Technique of ISRM (1986), it is generally necessary in this case to use large slots with large flat pressure jacks of 1000 x 1250 mm (LFJ) (see page no. 4). According to the theory of elasticity, a homogeneous isotropic semi-infinite mass that is subjected to a uniformly distributed load is governed by the following equation:

$$E = \left(1 - \nu^2\right) \frac{K}{\Delta s} \Delta p$$

ν = Poisson's ratio
K = Form coefficient with the dimension of a length
p = Oil pressure in the flat jack
s = Displacement

It is possible, therefore, to determine the modulus of rock deformation if the coefficient K is known. K-values for cells of 1000 mm width and 1250 mm overall length are shown in Fig. 2. Attention is also drawn to publications by LOUREIRO-PINTO (1981) listing further possibilities for the calculation of K-values.

Pressure cell arrangement	Position	K[cm]	Position	K[cm]
A B / C D	A, B C, D	131 136		
A B E F / C D G I	A, F B, E	150 191	C, I D, G	160 215
A B E F J L / C D G I M N	A, L B, J C, N	155 202 167	D, M E, F G, I	231 216 249
A B E F J L O P / C D G I M N Q R	A, P B, O C, R D, Q	157 206 170 237	E, L F, J G,N I, M	223 228 259 267

Fig. 2 K-values for various pressure cell combinations from DGEG (1984)

Geotechnisches Ingenieurbüro
Prof. Fecker & Partner GmbH
Am Reutgraben 9 Fon: ++7243/5983-7
D-76275 Ettlingen Fax: ++7243/5983-97

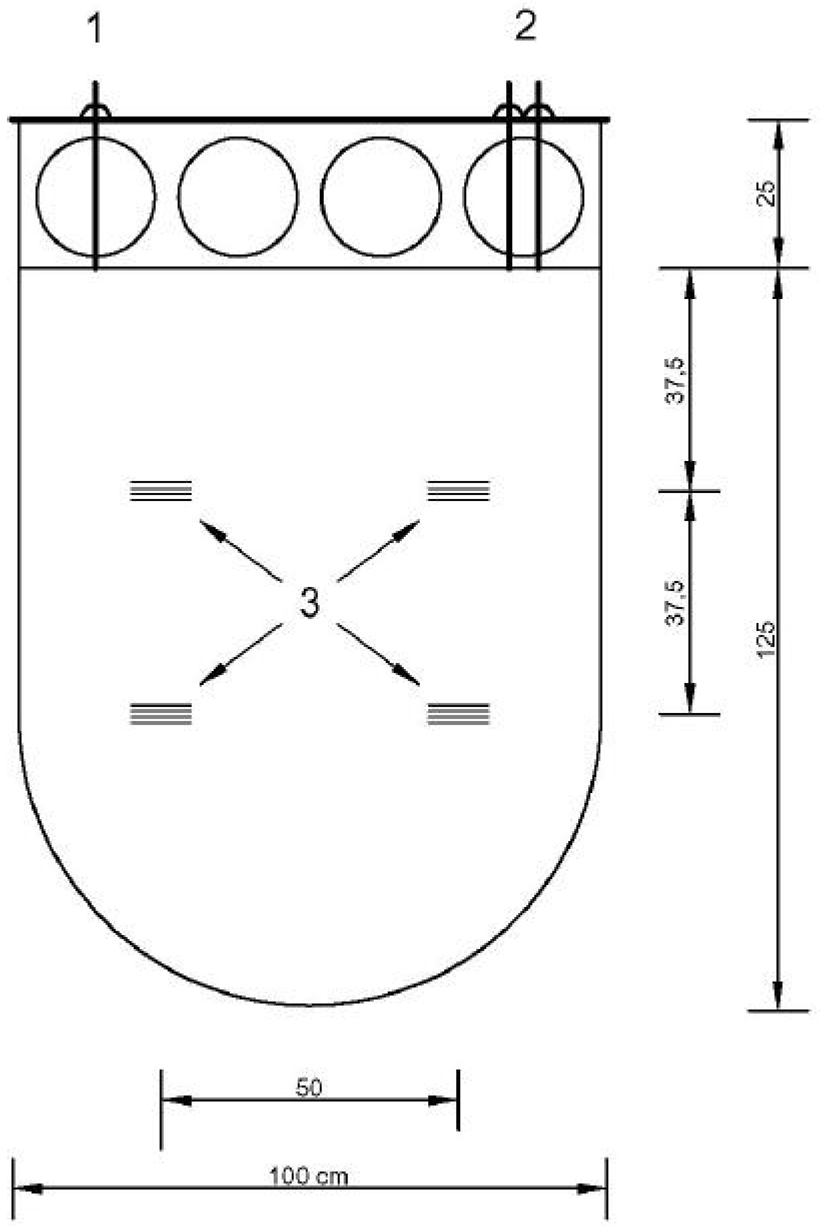

Fig. 3 Dimensions of Large Flat Jack (LFJ)
1 Oil inlet, 2 Strain gauge wiring, 3 Deformeters

Geotechnisches Ingenieurbüro
Prof. Fecker & Partner GmbH
Am Reutgraben 9 Fon: ++7243/5983-7
D-76275 Ettlingen Fax: ++7243/5983-97