

# Borehole Deformation Gage

## Applications

The Model 5000 Borehole Deformation Gage is designed for the measurement of in situ stresses in...

- Power houses
- Crushing stations
- Mines
- Tunnels
- Pit slopes
- Dam abutments



• Model 5000 Borehole Deformation Gage.

## Operating Principle

The measurement of in situ stresses is important in the design of underground openings such as power houses, crushing stations, mines, tunnels and the like. It is also useful for determining the inherent stability of pit slopes, foundation excavations, mine pillars and dam abutments.

If the rock is competent and elastic, then the stresses in it can be measured using the overcoring technique.

For many years, one of the most popular device for measuring in situ stresses has been the U.S. Bureau of Mines Borehole Deformation Gage. This device consists of three pairs of strain gaged cantilevers, each pair oriented at 120° to the next. These cantilevers are held within a sealed, stainless-steel housing, and their tips are deflected by means of tungsten carbide faced plungers.

The overcoring technique is as follows: the borehole gage is inserted inside an EX diamond drill hole so that the plungers are depressed and the initial deflection of the cantilevers is measured by connecting the signal cable to a conventional strain indicator readout (e.g. Vishay Model P3500) equipped with necessary switch and terminals.

With the gage still in the EX borehole, a 152 mm concentric hole is drilled around the gage so that it is eventually isolated from the stressed rock mass inside a 143 mm diameter core about 305 mm long.

As this core is liberated from the stress field it expands, and the resultant change in the diameter of the EX hole is measured by the strain gaged cantilevers. During this time the signal cable is located down the middle of the drill rods and issues from the back end through a special water swivel incorporating a water-tight gland.

After each overcore, the core is removed from the hole using core removal tools and placed inside a biaxial modulus chamber. This chamber incorporates a neoprene membrane which permits hydraulic pressure, applied by a hand pump, to be exerted radially on the rock core while the resultant change in the EX borehole diameter is once again measured by means of the borehole gage. The stress/strain relationship so measured is used to calculate the elastic modulus of the rock which then permits the rock stress to be computed from the measured strains during overcoring.

This procedure, repeated in three differently oriented boreholes, permits the magnitude and direction of the three principal stresses of the three dimensional state of stress to be calculated using an appropriate computer program supplied with the equipment.



● Model 5075 Biaxial Modulus Chamber.

### Advantages and Limitations

Overcoring is very difficult in rocks, which are too weak or too badly fractured to permit retrieval of diamond drill cores.

A primary advantage of the Borehole Deformation Gage is that it can be used repeatedly and does not require epoxy adhesives to cement the gage in place. A primary disadvantage is that measurement in three differently oriented boreholes is required to accurately characterize the full three-dimensional stress field.

The Borehole Deformation Gage is most useful in competent rocks in uniaxial or biaxial stress fields such as those encountered in mine pillars, and in locations close to the surface of the rock.

In rock which tends to fracture easily, “disc” or “poker chip” during overcoring, the borehole gage can be modified by replacing the standard housing with a “reverse case” which allows the cantilever plungers to be positioned very close to the start of the EX hole.

### System Components

Core removal tools include a wedge for breaking off the core; a rock anchor to insert and expand inside the EX hole (for holes oriented down); and a shovel to slide under and catch the core (for holes oriented horizontally).

A biaxial modulus chamber, with attendant pump and gage, is required to determine the modulus of deformation of the extracted rock core.

A calibration jig is available for periodic checks on the stability of the gage calibration. Other essential accessories include a water swivel with gland and setting rods for placing and orienting the gage. In addition, it is advisable to have on hand: spare cables, plungers, and biaxial modulus chamber membranes.

### Technical Specifications

Borehole Diameter	38 mm EX-size diamond drill hole
Resolution	1.0 $\mu\epsilon$
Minimum Overcore Depth	203 mm (25 mm with reverse case)
Maximum Overcore Depth	15 m standard (60 m with extra cable)
Temperature Range	-20°C to +80°C
Length $\times$ Diameter	267 $\times$ 35 mm