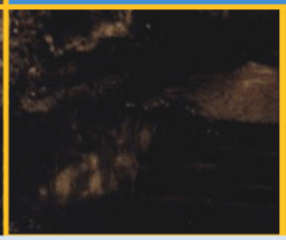
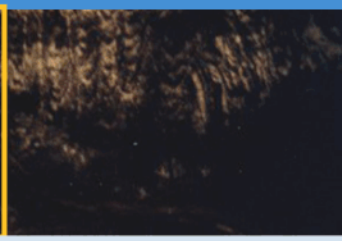
# ANZI STRESS CELL

## 3-Dimensional Measurements

Australia New Zealand Inflatable Stress Cell







- Advanced design with 18 gauges gives full redundancy
- Resolve 3D stress field
- Proven in coal and weak rock
- Measurement and monitoring capability
- Full service available

The ANZI (Australia New Zealand Inflatable) Stress Cell is an instrument for measuring three dimensional in situ stresses and stress changes in rock strata.

The ANZI Cell consists of a soft inflatable membrane with 18 electrical resistance strain gauges mounted flush on its outer surface. These gauges are glued to the surface of the borehole to directly measure any strain changes that occur in the rock.

The ANZI Cell has characteristics that:

- remove many of the drilling constraints
- extend the range of rock types in which stress measurements can be made
- greatly simplify the analysis procedure

The ANZI Cell has been used successfully in a wide range of conditions from coal and weak saturated sandstones through to very hard pebbly conglomerates and mass concrete.

The instrument is now widely used in underground mining investigations in Australia and has been used in United Kingdom, New Zealand, China Japan and Vietnam.

The ANZI Cell is currently produced in three sizes:

- 56mm version
- twin 56mm version
- 29mm version

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# ANZI Stress Cell

## Advantages

## Operational

The design of the ANZI Cell allows various other operational benefits that greatly speed up installation, reduce installation difficulty, and extend the range of rock types in which the instrument can be used.

These features include the following:

- Positive pressure, typically 100-300 kPa but anywhere up to 2000 kPa, is used to press the strain gauges against the rock on the borehole surface, ensuring the best possible contact is made even in wet rock conditions.
- The strain gauges are waterproofed so the ANZI Cell can be installed underwater in downhole applications.
- The body of the ANZI Cell is hollow so several instruments can be installed in the same hole at the same time with the cables from the deeper instruments passing through the shallower ones.
- In overcoring tests, it is typically convenient to do more than one test. To speed up this operation, two ANZI Cells sharing the same cable can be installed together.
- In monitoring, it is very convenient to be able to install more than one instrument in a single hole at large separations. Up to three ANZI Cells can be installed in the same hole.
- The ANZI Cell can be installed in holes where gas or water is issuing from the rock beyond the horizon where the cell is located as water make can pass through the instrument.
- There is no requirement for the instrument to be installed near the end of a hole so the borehole can be extended well beyond the measurement site and a suitable target horizon chosen later.

The major advantages offered by the ANZI Cell include:

- Quick and easy installation to extended depths.
- Operates in saturated rock conditions or even underwater in downhole applications.
- Up to three separate instruments can be installed in the same hole in monitoring applications.
- Two instruments sharing the same cable can be installed together in overcoring applications.
- Gauge debonding is not an issue even in low strength, highly stress rock.
- The overcored rock does not need to remain intact for a valid result to be obtained.
- Small diameter drilling gear can be used for overcoring.

## Analytical

The ANZI Cell membrane is of negligible stiffness compared to rock stiffness and can be ignored in the analysis. This characteristic greatly simplifies the analysis, removes many of the operational constraints that are necessary with other types of soft inclusion instruments, and extends the range of rock types in which the ANZI Cell can be used.

Among the advantages derived from the soft membrane are:

- small diameter drill gear can be used because the overcore diameter need only be slightly (10-22mm) greater than the pilot hole diameter. This feature significantly extends the range at which measurements can be made.
- the tensile stresses generated at the strain gauge – rock interface during overcoring are negligible so instrument debonding is not an issue even in low strength, highly stressed rock.
- the overcored rock does not need to remain intact for a valid result to be obtained

# ANZI Stress Cell

## Development History

In the early 1980s, an instrument was required to measure the in situ stress in soft rocks, particularly coal. The development focus was threefold:

1. To reduce the tensile stress at the instrument rock interface.
2. To measure the rock modulus and confirm instrument operation prior to overcoring.
3. To eliminate the dependence on an intact core to get a meaningful result.

These goals were successfully achieved with the development of the ANZSI (Auckland New Zealand Soft Inclusion) Cell at the University of Auckland, New Zealand in 1983 (Mills & Pender 1986). This instrument was used initially in coal to measure in situ stresses and monitor stress changes due to mining activity. It was also used in investigations for underground hydroelectric projects in New Zealand in strongly foliated rock were the analytical simplicity offered significant benefits for interpreting the anisotropic rock behaviour.

Since 1990, Strata Control Technology have undertaken ongoing developments and the name of the instrument has been modified to reflect this input. Extensive field testing and verification trials have underpinned the development program.

The ANZI Cell has been used successfully in a wide range of conditions from coal and weak saturated sandstones through to very hard pebbly conglomerates and mass concrete.

The ANZI Cell is now widely used in underground mining investigations in Australia. It has also been used in the United Kingdom, China, Japan, New Zealand and Vietnam, in both coal and hard rock applications.

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*Reference*
*Mills K.W. 1997. "In situ stress measurement using the ANZI stress cell" Rock Stress, Sugawara & Obara (eds) Balkema ISBN 90-5410-9017, pp 149-154.*

# ANZI Stress Cell

## Operation

To install the ANZI Cell, the surface of the membrane and the strain gauges are coated with low slump epoxy cement. The instrument is inserted into a pilot borehole and pneumatically inflated at the target depth. When the cement has cured (6-36 hours depending on temperature and adhesive selection) the strain gauges are bonded directly to the surface of the borehole.

Once the cement has cured, a pressure test is conducted using the ANZI Cell as a borehole dilatometer or pressuremeter. Although the pressures used in this test are kept relatively low to avoid disturbing the in situ stress field, the strain changes obtained give confirmation of the correct operation of all the gauges and a measure of the modulus of the rock in situ before it is disturbed by overcoring.

The overcoring operation is conducted in much the same way as for other instruments that use the overcoring stress-relief method.

The instrument is monitored throughout the overcoring operation via a cable that passes down the centre of the drill string and out through the water swivel on the drilling machine.

The eighteen strain gauges on the ANZI Cell give a high degree of redundancy that allows internal cross checking between independent strain readings. There are sufficient gauges on each instrument to make two completely independent stress determinations in each test.

A biaxial pressure test is conducted on the core once it is recovered to measure elastic modulus and Poisson's Ratio. If the core is too badly damaged to do a biaxial test, the elastic modulus can be estimated from the pressuremeter test conducted prior to overcoring.

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