

Earth Pressure Cells

Applications

Earth Pressure Cells provide a direct means of measuring total pressures, i.e. the combination of effective soil stress and pore water pressure, in or on...

- Bridge abutments
- Diaphragm walls
- Fills and embankments
- Retaining walls surfaces
- Sheet piling
- Slurry walls
- Tunnel linings

They may also be used to measure earth bearing pressures on foundation slabs and footings and at the tips of piles.



• Model 4800 Earth Pressure Cell (front), Model 4820 Jackout Pressure Cell (center) and Model 4810 Contact Pressure Cell (rear).

Operating Principle

Earth Pressure Cells are constructed from two stainless steel plates welded together around their periphery and separated by a narrow gap filled with hydraulic fluid. External pressures squeeze the two plates together creating an equal pressure in the internal fluid. A length of stainless steel tubing connects the fluid filled cavity to a pressure transducer that converts the fluid pressure into an electrical signal transmitted by cable to the readout location.

Advantages & Limitations

The 4800 Series Earth Pressure Cells use vibrating wire pressure transducers and thus have the advantages of long term stability, reliable performance with long cables and insensitivity to moisture intrusion. All models also include a thermistor for temperature measurements and a gas discharge tube for lightning protection. Where dynamic stress changes are to be measured a semiconductor type pressure transducer is substituted (see Model 3500).

Cell performance depends strongly on the surrounding soil properties. It would be prohibitively expensive to

calibrate a cell in the soil type specific to the application being contemplated. However, studies have shown that the most consistent cell performance is achieved using cells of maximum stiffness with aspect ratios $D/t > 10$ (D is the diameter of the cell, t the thickness). With **GEOKON®** cells, maximum stiffness is achieved by using hydraulic oil with less than 2 ppm of dissolved gas and aspect ratios generally greater than 20 to 30. Tests on **GEOKON®** cells in various types of soil have shown that the cells over-register the soil pressure by less than 5 percent. This is probably no greater than the inherent variability of the soil pressure distribution in the ground.

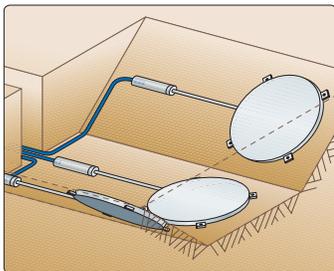
Typical of all closed hydraulic systems, earth pressure cells are sensitive to temperature changes which cause the internal fluid to expand at a different rate than the surrounding soil giving rise to spurious fluid pressure changes. The magnitude of the effect depends to a greater extent on the elasticity of the surrounding soil, i.e., on the degree of compaction and confinement, and is difficult to predict and correct for. The built-in thermistor is helpful in separating these spurious effects from real earth pressure changes.

Model 4800, 4815 Earth Pressure Cells



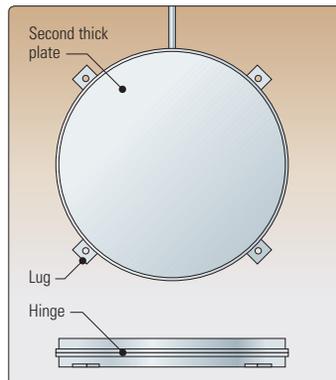
● Model 4800 Earth Pressure Cell.

Model 4800 cells are constructed from two thin pressure sensitive plates. They can be positioned in the fill at different orientations so that soil pressures can be measured in two or three directions. Special armored cables are recommended in earth dam applications.

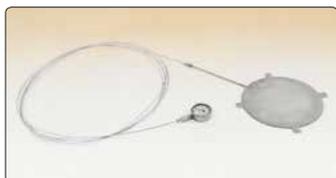


● Model 4800 Earth Pressure Cells installed in fill for soil pressure measurement in three directions.

The Model 4815 is a special cell that effectively reduces the severity of point loading when used in granular materials. The modification uses two thick plates welded together at a flexible hinge that helps provide more uniform pressure distribution.



● Model 4815 pressure cell, with two thick plates, for use in granular materials.



● Model 4800 Earth Pressure Cell with a Bourdon Tube Pressure Gauge.

Models 4800, 4810 and 4815 are also available with a Bourdon Tube Pressure Gauge (2½" dial) in place of the vibrating wire pressure transducer. The pressure gauge is liquid-filled and features stainless steel wetted parts, a stainless steel case and crimp ring. Available in pressure ranges up to 15,000 psi (103 MPa) (1.5% span accuracy).

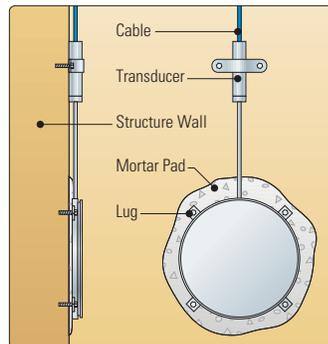
Model 4810 Contact Pressure Cells



● Model 4810 Contact Pressure Cell for attachment to existing concrete surfaces.

The Model 4810 Contact Pressure Cell is designed to measure soil pressures on structures. The backplate of the cell which bears against the external surface of the structure is thick enough to prevent the cell from warping. The other plate is thin and is welded to the backplate in a manner which creates a flexible hinge to provide maximum sensitivity to changing soil pressures.

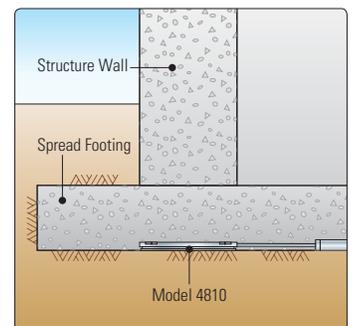
Lugs on the side provide a means of mounting the cell to concrete forms or to steel or concrete surfaces. A mortar pad beneath the backplate ensures good contact with the struc-



● Side and frontal views of the Model 4810 installed on existing structure.

ture surface. Cells are best installed flush with the surface to which they are attached. The fill material next to the cell should be screened to remove pieces larger than 10 mm.

Cells installed at the base of slabs and footings to measure bearing loads should always be positioned inside the concrete with the sensitive face pressed against the compacted fill. Cells placed in the fill below the concrete often become decoupled from the soil pressure due to the impossibility of adequately compacting the fill around the cell.



● Model 4810 installation in a spread footing.

Model 4820 Jackout Pressure Cells

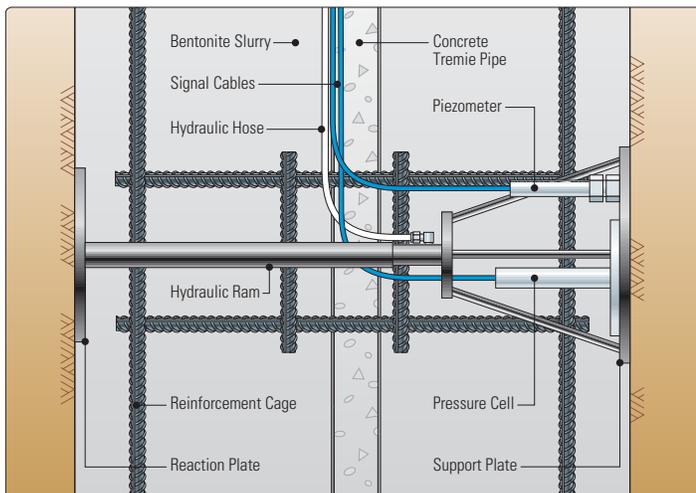


● Model 4820 shown in hydraulic ram assembly with piezometer and alone (inset).

The Jackout Pressure Cell is designed for installation in diaphragm walls (slurry walls) to monitor soil pressures on the walls as excavation proceeds. This allows the build-up of excessive pressures to be detected in time to take remedial measures.

The Jackout Pressure Cell assembly consists of the cell mounted on a support plate, a reaction plate and a hydraulic ram. This assembly is attached, in its retracted position, to the reinforcement cage and is lowered into the slurry trench along

with the cage. When the cage is in position the hydraulic ram is extended by means of a hand pump situated at the top of the wall and connected to the ram by a hydraulic hose. Pressure is applied forcing the reaction plate and the cell against the walls of the trench. This pressure is maintained while the concrete is tremied into the trench and until the concrete cures. The cell may be supplemented by a piezometer attached to the support plate to measure pore water pressures.



● Jackout Pressure Cell assembly installed in diaphragm wall.

Model 4830 Push-In Pressure Cell

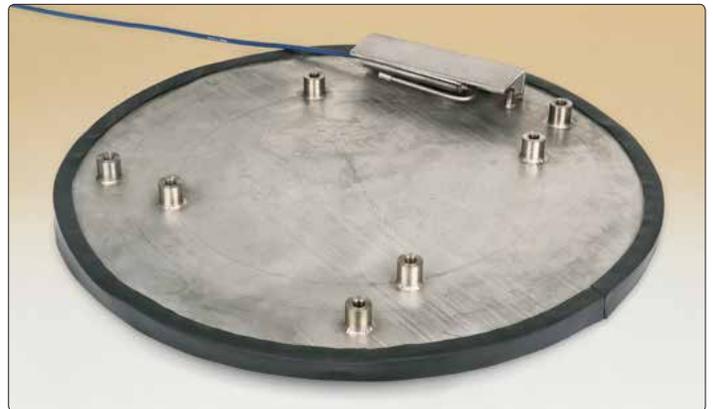


● Model 4830 Push-In Pressure Cell.

The Model 4830 Push-In Pressure Cell is designed to be pushed in place for the measurement of total pressures in soils and earth fills. Where effective stress is required, the cell is fitted with an integral piezometer. A thread is provided on the end of the

cell to allow for installation using lengths of pipe or drill rods. Models are also available (3500 Series) with semiconductor pressure transducers to enable measurement of dynamic pressures (please contact **GEOKON®** for details).

Model 4855 Pile Tip Pressure Cell

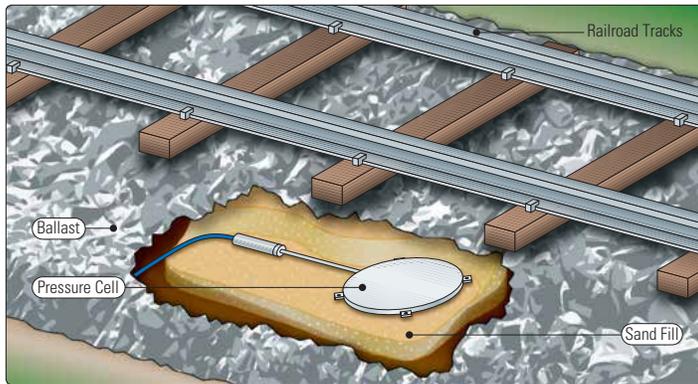


● Model 4855 Pile Tip Pressure Cell.

The Model 4855 Pile Tip Pressure Cell is used to measure pile-tip loads in cast-in-place concrete piles (caissons). Like the Model 4810, the Pile Tip Pressure Cell has a thick upper plate. The cell is manufactured to be close to the diameter of the pile and the back plate is supplied with hooks or sections of rebar to allow the cell to be connected to the bottom of the

reinforcement cage. An added feature is a remote "crimping" mechanism to allow the cell to be inflated slightly so as to ensure good contact between the cell and the surrounding concrete.

Model 3500 Series Earth Pressure Cells



● Model 3500 Earth Pressure Cell installed under railroad tracks.

The 3500 Series is similar in design to the 4800 Series but the vibrating wire transducer is replaced by a semiconductor type transducer (to enable the measurement of dynamic pressures) which can have an output of 2 mV/V, 0-5 VDC or 4-20 mA.

Typical applications are the measurement of traffic induced stresses on roadway sub grades, airport runways or under railroad tracks.

Technical Specifications

	4800	4810	4815	4820	4830	4855	3500
Transducer Type	Vibrating Wire	Vibrating Wire	Vibrating Wire	Vibrating Wire	Vibrating Wire	Vibrating Wire	Semiconductor
Output	2000-3000 Hz	2000-3000 Hz	2000-3000 Hz	2000-3000 Hz	2000-3000 Hz	2000-3000 Hz	2 mV/V, 0-5 VDC or 4-20 mA
Standard Ranges ¹	70, 170, 350, 700 kPa; 1, 2, 3, 5, 7.5, 20 MPa	350, 700 kPa; 1, 2, 3, 5 MPa	350, 700 kPa 1, 2, 3, 5 MPa	350, 700 kPa; 1, 2, 3, 5 MPa	70, 170, 350, 700 kPa; 1, 2, 3, 5 MPa	2, 3, 5, 7.5, 10, 20 MPa	100, 250, 400, 600 kPa; 1, 2.5, 6 MPa
Over Range	1.5 × rated pressure	1.5 × rated pressure	1.5 × rated pressure	1.5 × rated pressure	1.5 × rated pressure	1.5 × rated pressure	1.5 × rated pressure
Resolution	±0.025% F.S.	±0.025% F.S.	±0.025% F.S.	±0.025% F.S.	±0.025% F.S.	±0.025% F.S.	Infinite
Accuracy ²	±0.1% F.S.	±0.1% F.S.	±0.1% F.S.	±0.1% F.S.	±0.1% F.S.	±0.1% F.S.	±0.25% F.S. ³
Linearity	< 0.5% F.S.	< 0.5% F.S.	< 0.5% F.S.	< 0.5% F.S.	< 0.5% F.S.	< 0.5% F.S.	< 0.5% F.S.
Thermal Effect on Zero	< 0.05% F.S.	< 0.05% F.S.	< 0.05% F.S.	< 0.05% F.S.	< 0.05% F.S.	< 0.05% F.S.	< 0.05% F.S.
Typical Long-Term Drift	< 0.02% F.S./yr	< 0.02% F.S./yr	< 0.02% F.S./yr	< 0.02% F.S./yr	< 0.02% F.S./yr	< 0.02% F.S./yr	< ±0.02% F.S./yr
Cell Dimensions (H × D) ⁴	6 × 230 mm	12 × 230 mm	26 × 230 mm	12 × 150 mm	12 × 150 mm	50 × 600 mm	6 × 230 mm
Transducer Dimensions (L × D)	150 × 25 mm	150 × 25 mm	150 × 25 mm	150 × 25 mm	150 × 25 mm	(included in above)	150 × 32 mm
Excitation Voltage	2.5-12 V swept square wave	2.5-12 V swept square wave	2.5-12 V swept square wave	2.5-12 V swept square wave	2.5-12 V swept square wave	2.5-12 V swept square wave	10 V maximum
Excitation Frequency	1400-3500 Hz	1400-3500 Hz	1400-3500 Hz	1400-3500 Hz	1400-3500 Hz	1400-3500 Hz	n/a
Material	Stainless Steel	Stainless Steel	Stainless Steel	Stainless Steel	Stainless Steel	Stainless Steel	Stainless Steel
Temperature Range ¹	-20°C to +80°C	-20°C to +80°C	-20°C to +80°C	-20°C to +80°C	-20°C to +80°C	-20°C to +80°C	-20°C to +80°C

Note: PSI = kPa × 0.14503, or MPa × 145.03

¹ Other ranges available on request.

² Stated accuracy is for the pressure transducer alone. The total system accuracy (pressure transducer + pressure cell) is subject to site-specific variables.

³ Accuracy of 0.1% available on request.

⁴ Other sizes available on request.