

■ DYNATEST IN-SITU STRESS AND STRAIN TRANSDUCERS

Based on years of research, development and experience at the Technical University of Denmark, Dynatest is manufacturing two series of transducers for the measurement of in-situ stresses and strains, primarily for highway and airfield pavements:

- **The Dynatest PAST Series:** (Pavement Strain Transducers) for the measurement of strain in AC (Asphalt Concrete) or PCC (Portland Cement Concrete) pavements.
- **The Dynatest SOPT Series:** (Soil Pressure Transducers) for the measurement of pressure (stress) in unbound materials like gravel, sand or clay.

■ THE NEED FOR MEASUREMENT OF IN-SITU STRESSES & STRAINS

Several computer programs based on elastic theory are available for the computation of stresses and strains in pavement structures. The Dynatest PAST series and SOPT series transducers may be used to verify these computed values. This is very important, as stress or strain in a certain layer of a road construction is normally used as the critical parameter for determining the performance of the pavement sections, including the service life as a function of the number of imposed wheel loads.

■ DYNATEST TRANSDUCERS: TIME TESTED RELIABILITY

Dynatest series PAST and SOPT transducers are precision instruments which have been developed and constructed for their specific purpose based on more than a decade of in-situ experience. The latest technology and the highest quality materials have made these transducers particularly resistant to the often tough environments in which they will be used. The end result is long service and fatigue lifetimes.

PAST (Pavement Strain Transducers)

The PAST series transducer is an “H” shaped precision transducer (see *Photo 1*) for measurement of strain in AC (Asphalt Concrete) or PCC (Portland Cement Concrete) as mentioned above.

It must be installed in any lateral position, typically in the bottom of a pavement top layer for measurement of longitudinal strain, which is often used as a critical parameter in pavement design.

The “heart” of the PAST transducer is a strain gauge completely embedded in a strip of glass-fibre reinforced epoxy, a material with a relatively low stiffness and a high flexibility and strength. Each end of the epoxy strip is securely fastened to a stainless steel anchor to ensure proper mechanical coupling to the AC (or PCC) material after installation.

The strain gauge strip is protected against mechanical and chemical deterioration by means of a multi-layer “coating”. This combination of materials, plus a connecting cable made from PTFE, ensures resistance to temperatures in the range of -30°C (-20°F) to 150°C (300°F).

The PAST transducer has a nominal resistance of 120 ohms and a gauge factor of 2.0. It can be incorporated into a full bridge setup with up to 12V excitation voltage.

The average E-modulus of the cell body is as low as 2,200 MPa due to the special properties of the cell materials. A cross section area of only 0.5 sq. cm results in an extremely low “cell force” of 0.11 N/microstrain. This ensures a negligible influence on the surrounding material, resulting in accurate measurements.

The strain gauge strip of the PAST II is so effectively coated and protected that the service life exceeds 36 months and the fatigue life exceeds 100,000,000 cycles.

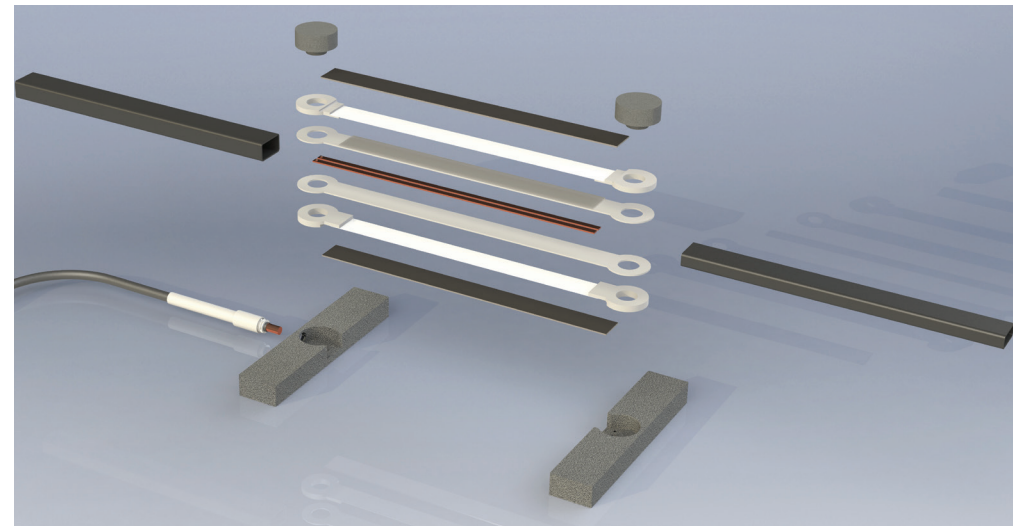


Photo 1 PAST (Pavement Strain Transducer)

PCCST (Portland Cement Concrete Strain Transducer)

For use in PCC Pavements only, a PCCST transducer has been developed, with a narrower temperature range and at a reduced cost. Please see Table 1 for specification of the PAST and PCCST transducers.

Specifications			
Type	PAST II (For AC or PCC)		PCCST (for PCC only)
Range	Up to 1500 μ strain		Do.
Configuration	Single strain gage (1/4 bridge)		Do.
Cell material	Epoxy—Fiberglass		Do.
Coating	Epoxy—Silicone—PFT—Titanium		Epoxy—Silicone—PFT
Resistance	120 Ω \pm 1.0 %; GF=2.0		Do.
Voltage	Up to 12V (full bridge)		Do.
Temperature	-30° to 150°C	-22° to 300°F	-10° to 60°C 14° to 140°F
Σ E-modulus	\approx 2200 MPa	\approx 320 ksi	14,000 MPa \approx 2000 ksi
Cross section	\approx 0.5 sq. cm	\approx 0.078 sq. in	0.25 sq. cm \approx 0.04 sq. in
Cell Force	0.110 N/ μ strain	\approx 0.024 lbf/ μ strain	0.35 N/ μ strain \approx 0.08 lbf/ μ strain
Fatigue life	Theoretically up to 10 ⁸ cycles		Do.
Service life	Typically > 36 months		Do.

Table 1 PAST II and PCCST Transducers Specifications

SOPT (Soil Pressure Transducers)

The SOPT series transducers are precision made gauges for the measurement of pressure (stress) in cohesive as well as non-cohesive materials (soils) like clay, sand, gravel, etc.

These transducers are normally used to measure vertical stress in different levels of the unbound layers of a pavement construction and in particular vertical stress in the top of the subbase, which is often used as a critical parameter in pavement design.

The SOPT transducer is based on a special design which yields drastic advantages over the “normal” membrane type cells with respect to linearity and sensitivity.

The major drawback of membrane type cells has been their poor linearity. To compensate for this, the membranes of cells of this type were made very stiff resulting in poor sensitivity and resolution. Even with a stiff membrane, the linearity was dependent on the type of soil and on the soil moisture content making error compensation very difficult.

These linearity/sensitivity problems with the (stiff) membrane type cells have been virtually eliminated with the Dynatest SOPT “hydraulic” design, which utilizes a thin membrane (0.5 mm/20 mil) over the entire cell area. The interior of the cell is completely filled with a liquid, and an integrated pressure transducer measures the liquid pressure. This creates an almost constant cell volume and allows the cell to be sensitive to pressure over its entire area—two characteristics resulting in excellent linearity in all types of soils.

The entire cell body, including the thin membrane, is made from pure titanium, ensuring maximum resistance to galvanic and mechanical deterioration. In addition, the cell is coated with epoxy and sand to ensure good performance even in materials like uniformly graded sands.

- SOPT 68A for a pressure range of 10 to 200 kPa
- SOPT 68B for a pressure range of 100 to 800 kPa

The SOPT cell is available in two versions:

Specifications		
Type	SOPT 68A	SOPT 68B
Range	10–200 kPa (≈ 1.5 to 30 psi)	100–800 kPa (≈ 15 to 120 psi)
Cell material	Pure titanium	
Coating	Epoxy and sand	
Temperature range	–30° to 150° C (–22° to 300°F)	
Resistance	4 × 350 Ω (full bridge)	
Function	Linear for E-modulus < 500 MPa (≈ 70 ksi)	
Output	Refer to Calibration Certificate	
Bridge Excitation Voltage	12V max.	
Fatigue life	More than 3 × 10 ⁶ cycles	
Service life	> 36 months	

Table 2 SOPT Specifications

The internal pressure transducer has a full strain gauge bridge which is temperature compensated for use in the range of –15°C to 150°C (5°F to 300°F). The maximum bridge excitation voltage is 12 volts.

All of these qualities plus a unique internal gauge protection give the SOPT cells a service life of more than 36 months and a fatigue life of more than 3 × 10⁶ cycles.

Each SOPT cell is delivered with an individual calibration certificate based on test results obtained in a sand filled pressure chamber (see Table 2 for specifications of both versions of the SOPT cell).

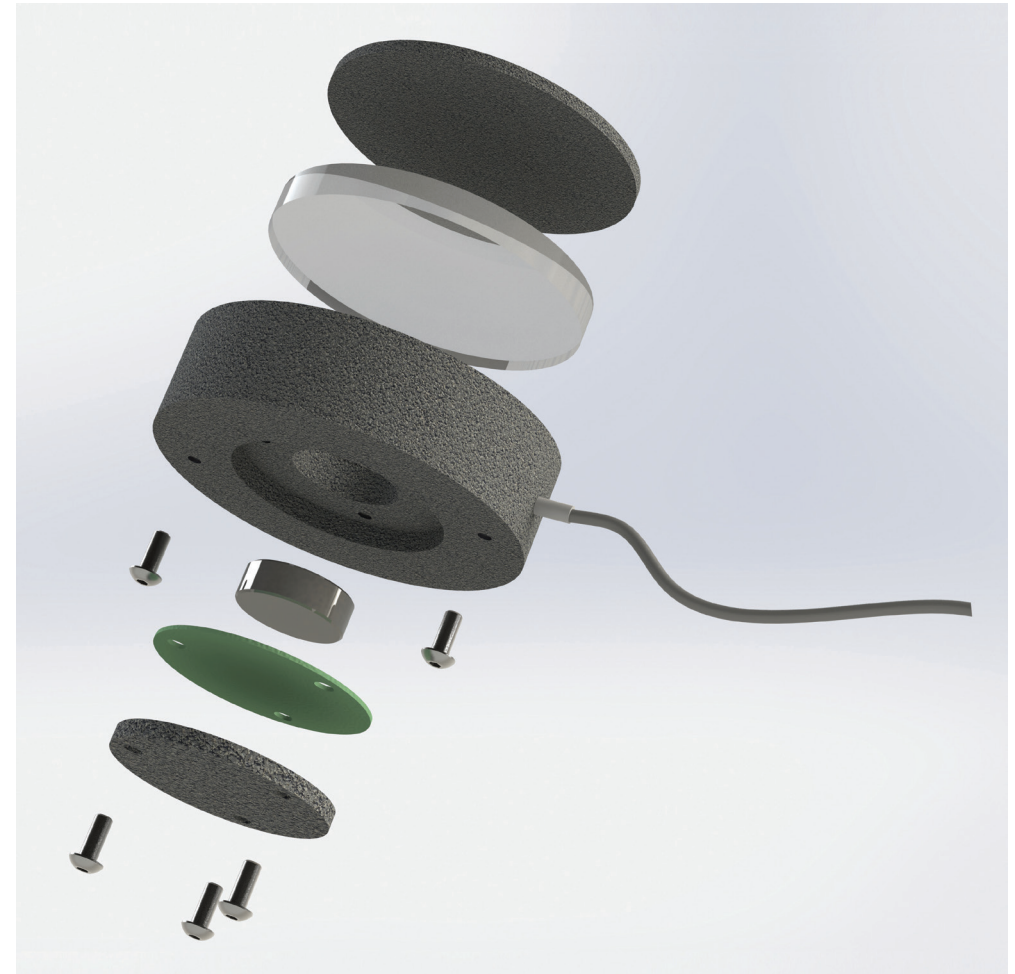


Photo 2 SOPT Series Soil Pressure Transducer