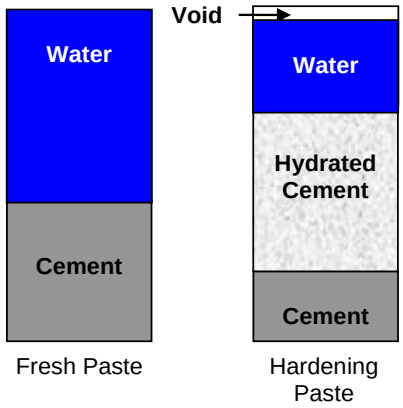
Auto-Shrink

Purpose

The **Auto-Shrink** system measures the unrestrained autogenous shrinkage of a specimen of cement paste or mortar cured under sealed conditions (ASTM C1698, Test Method for Autogenous Strain of Cement Paste and Mortar). **Auto-Shrink** permits evaluation of the relative autogenous shrinkage potential of different cementitious systems. Excessive autogenous shrinkage may lead to microcracking that increases the permeability of concrete.

Principle

When cement hydrates through chemical reactions with water, the volume occupied by the products of hydration is less than the original volume of cement and water and thus internal voids are created. This phenomenon is known as "chemical shrinkage." If concrete is cured under sealed conditions (no external source of water or moisture), the reduction in paste volume due to this hydration process can cause shrinkage and this in turn produces internal tensile stresses that may lead to microcracking. The microcracking reduces concrete's resistance to penetration of water and deleterious substances.



If a specimen of paste or mortar is cured under sealed conditions and allowed to change in volume, the chemical shrinkage of the paste will cause **autogenous shrinkage** of the specimen. The **Auto-Shrink** digital dilatometer is designed for linear measurement of autogenous shrinkage in hardening cement-based materials. A special corrugated plastic mold is used to prevent moisture loss and allow the specimen to shrink freely. With **Auto-Shrink,** it is possible to measure the time dependent deformation of different specimens simultaneously over periods of weeks or even years. **Auto-Shrink** is intended primarily for measurements after setting of cement pastes or mortars with a maximum aggregate size of 4 mm (preferably 2 mm). To minimize the influence of temperature variations, the dilatometer should be used in a thermostatically controlled room. Background information on the measurement technique used in **Auto-Shrink** can be found in the following reference:

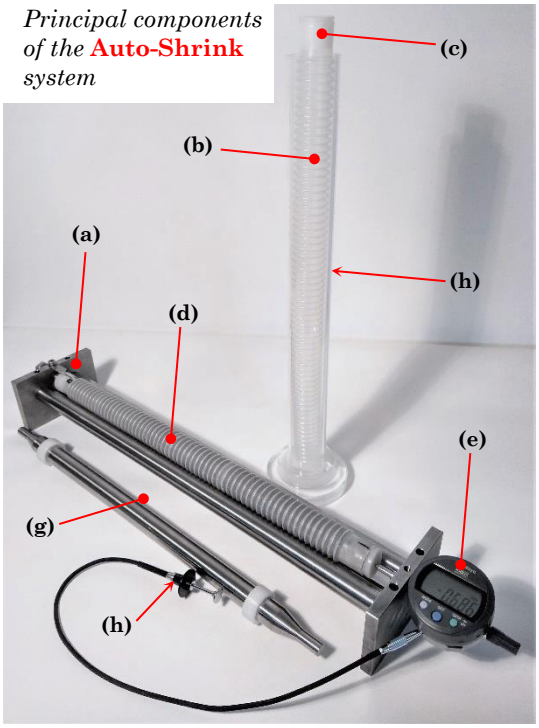
> Mejlhede Jensen, O. and Freiesleben Hansen, P. "A Dilatometer for Measuring Autogenous Deformation in Hardening Portland Cement Paste," *Materials and Structures*, 1995, 28 (181) 406-409

Auto-Shrink System

The **Auto-Shrink** digital dilatometer is composed of the following basic elements:

- A rigid frame or bench to support the specimen (a), whose rods are made of Invar, a special steel alloy with a very low coefficient of thermal expansion at room temperature.
- A corrugated plastic mold (b) with 2 sealing plugs (c) to prepare a slender test specimen (d).
- A high precision digital dial gauge (e) with remote control (f) to measure change in specimen length.
- A reference bar (g) made of Invar steel as well.
- A support tube (h) to cast the concrete into the corrugated tube.
- The digital displacement gauge is fixed firmly to the frame with a blunted hex screw. The remote control is mounted on the side of the gauge. A lock function for the remote control is provided.

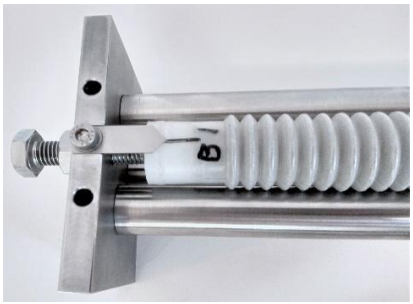
Principal components of the **Auto-Shrink** *system*



Specimens are cast vertically by using a support tube, which can be mounted to a vibrating table. To ensure that the cast specimens have approximately the same length, the corrugated mold should not be stretched or

compressed during filling. The mold is filled to approximately 15 mm below the end of the tube to allow room for the top sealing plug. Before the top sealing plug is mounted, the corrugated tube is compressed slightly to bring the cement paste in contact with the sealing plug.

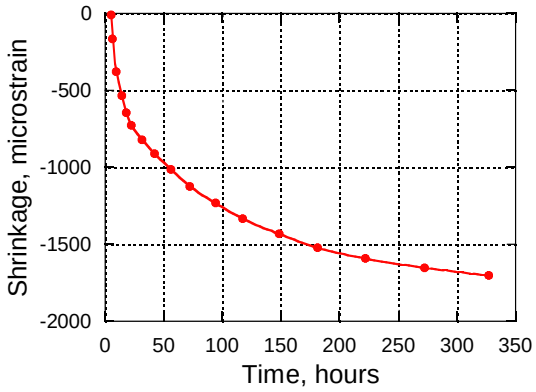
Measurements in the **Auto-Shrink** dilatometer are conveniently done relative to a reference bar. To ensure optimal measuring accuracy, the reference bar as well as the specimens should be placed in the frame in the same orientation during each measurement. A line mark with permanent ink at one end of the corrugated tube may be used to indicate the proper orientation of the specimen during length measurement in the dilatometer.



As an option, a special USB input cable and software can be purchased to connect the displacement gauge to a computer for automatic recording of length change to a spreadsheet file. The software allows gauges from multiple measurement frames to be read automatically. The cables are connected to the computer with a commercial USB hub.

Testing Example

The following graph is an example of very high autogenous strain measured over 2 weeks on a cement paste (*w/c ratio* of 0.25) with 10 % silica fume cured at 30 °C. Time is measured from the addition of water. The strain has been defined as 0 at the time of final setting of the paste (from Mejlhede Jensen and Freiesleben Hansen, 1995).



Auto-Shrink Specifications

- Support frame and reference bar made of **Invar** steel alloy
- Absolute type linear encoder Digital Gauge with large, easy-to-read LCD rotating display
- Measuring range: 12.7 mm
- Resolution: 0.001 mm
- Accuracy at 20°C: 0.003 mm
- Repeatability at 20°C: 0.002 mm
- 8 mm stem with a 1.5 mm spherical tip (carbide tipped)
- Battery life: ≈ 7,000 hours of continuous use
- Service temperature range: 0 to 40°C
- Storage temperature range: 0 to 60°C

Auto-Shrink AS-1000 Kit Ordering Numbers

Item	Order #
Dilatometer support frame with stop pin	AS-1100
Digital displacement gauge including lifting cable as remote control	AS-1110
Reference bar	AS-1120
Spanner 17 mm	AS-1130
Hex key 2½ mm	AS-1140
Support tube for casting	AS-1170
Grooved support rack for 10 specimens, set of 5 pcs.	AS-1180

Optional items for automatic data-logging

Item	Order #
USB Input tool direct cable	AS-1200
ITPak software with USB dongle	AS-1210

Consumables

Item	Order #
Corrugated tubes, set of 50 pcs.	AS-1150
Sealing plugs, set of 100 pcs.	AS-1160