ShapeArray is your smart solution for geotechnical monitoring.
An integrated, streamlined approach to reducing risk.

DEFORMATION CAPTURE SIMPLIFIED.
ShapeArray is an integrated measuring tool that measures deformation in soil and structures in real-time. The instrument can be used vertically, horizontally, or in an arc, to measure lateral deformation, settlement, or convergence. ShapeArray’s design—rigid stainless steel sensorized segments connected by flexible joints—is durable and allows for simple installation from its shipping reel. Every segment of ShapeArray contains three MEMS tilt sensors, a microprocessor and digital temperature sensor.
EASY. RESILIENT. SAAV

- **Casing Cap**
  holds SAAV in compression.

- **Extension Tubes**
  occupy space at top, if sensors are not needed near the surface.

- **Sensorized Segments**
  With the cyclical installation system (patent pending), segments zigzag within the casing, enabling easy installation and the re-use of casings.

- **Silent Segments**
  occupy space at the bottom, if sensors are not needed there. Can be added or removed in the field.
EXTENSION TUBES & SILENT SEGMENTS

SAAV is designed to provide maximum flexibility and control. Extension tubes and silent segments permit placing the SAAV’s sensorized segments in a region of interest.

CYCLICAL INSTALLATION

The cyclical installation system (patent pending) enables a stable fit into either new or distorted casings up to 100 mm in diameter. SAAV takes reel-to-hole installation to a new level. No other inclinometer system is as easy or resilient to deformation.
The most advanced ShapeArray makes installation even simpler with off-the-reel cyclical installation into casings up to 100 mm in diameter. Optional silent segments offer flexibility for users to control the location of the sensorized zone.

**Segment Length:**
500 mm

**Installation:**
Vertical/Horizontal\(^1\)/Convergence\(^1\)

**Applications:**
Permanent/Temporary
### PHYSICAL PROPERTIES

<table>
<thead>
<tr>
<th>Physical Property</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>SEGMENT LENGTH</strong></td>
<td>500 mm (Joint centre to joint centre)</td>
</tr>
<tr>
<td><strong>CASING INSIDE DIAMETERS</strong></td>
<td>47 mm to 100 mm (Other sizes late 2017)</td>
</tr>
<tr>
<td><strong>STANDARD LENGTH OF SAAV</strong></td>
<td>0.5 m to 150 m (500 mm segments)</td>
</tr>
<tr>
<td><strong>CUSTOM LENGTH OF SAAV</strong></td>
<td>Over 150 m (Contact Measurand for details)</td>
</tr>
<tr>
<td><strong>LENGTH OF FIBERGLASS EXTENSION</strong></td>
<td>1 m to 100 m</td>
</tr>
<tr>
<td><strong>LENGTH OF COMMUNICATION CABLE</strong></td>
<td>15 m standard</td>
</tr>
<tr>
<td><strong>ACCURACY OF DEFORMATION RELATIVE TO STARTING SHAPE</strong></td>
<td>± 1.5 mm for 32 m ShapeArray</td>
</tr>
<tr>
<td><strong>RESOLUTION OF SINGLE SEGMENT</strong></td>
<td>± 1 arcsecond</td>
</tr>
</tbody>
</table>

2. One-sigma value, based on cyclical installation in 59 mm ID casing. Accuracy degrades as square root of length.
3. Value based on AIA (Average in Array) setting of 1000 samples.
4. Specification is for 3D mode within ± 20° of vertical. Vertical accuracy degrades with angular deviation from the vertical.
5. RMS calculated from published noise figure of sensor (verified by Measurand Inc.) and bandwidth of system using highest AIA setting of 25,600 samples.
**SAAF**

Versatile and flexible, SAAF is the most popular ShapeArray model. A range of available segment lengths tailors spatial resolution and maximum curvature. Ideal for long-term monitoring horizontally, vertically, or in an arc.

- **Segment Length:**
  - 200, 305, and 500 mm

- **Installation:**
  - Vertical/Horizontal/Convergence

- **Applications:**
  - Permanent
## PHYSICAL PROPERTIES

<table>
<thead>
<tr>
<th>SEGMENT LENGTH&lt;sup&gt;1&lt;/sup&gt;</th>
<th>200, 305, 500 mm (Joint centre to joint centre)</th>
</tr>
</thead>
<tbody>
<tr>
<td>CASING INSIDE DIAMETERS</td>
<td>27 mm ID PVC</td>
</tr>
<tr>
<td>STANDARD LENGTH OF SAAF</td>
<td>0.305 m to 60.96 m (305 mm segments), 0.5 m to 150 m (500 mm segments)</td>
</tr>
<tr>
<td>CUSTOM LENGTH OF SAAF</td>
<td>Over 150 m (Contact Measurand for details)</td>
</tr>
<tr>
<td>LENGTH OF PEX TUBING</td>
<td>1.5 m standard</td>
</tr>
<tr>
<td>LENGTH OF COMMUNICATION CABLE</td>
<td>15 m standard (13.5 m extends past PEX tubing)</td>
</tr>
<tr>
<td>ACCURACY OF DEFORMATION RELATIVE TO STARTING SHAPE&lt;sup&gt;234&lt;/sup&gt;</td>
<td>± 1.5 mm for 32 m ShapeArray</td>
</tr>
<tr>
<td>RESOLUTION OF SINGLE SEGMENT&lt;sup&gt;45&lt;/sup&gt;</td>
<td>± 2 arcseconds</td>
</tr>
</tbody>
</table>

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<sup>1</sup> Custom segment lengths between 200 mm and 305 mm are available at extra cost.

<sup>2</sup> One-sigma value, based on cyclical installation in 27 mm ID casing. Accuracy degrades as square root of length.

<sup>3</sup> Value based on AIA (Average in Array) setting of 1000 samples.

<sup>4</sup> Specification is for 3D mode within ± 20° of vertical. Vertical accuracy degrades with angular deviation from the vertical.

<sup>5</sup> RMS calculated from published noise figure of sensor (verified by Measurand Inc.) and bandwidth of system using highest AIA setting of 25,600 samples.
Purpose-built with longer one metre segments for heavy duty horizontal installation: soil settlement, rail-line deformation, and pipeline monitoring.

Segment Length: 1000 mm
Installation: Horizontal
Applications: Permanent/Temporary
## PHYSICAL PROPERTIES

<table>
<thead>
<tr>
<th>Description</th>
<th>Measurement</th>
</tr>
</thead>
<tbody>
<tr>
<td>SEGMENT LENGTH</td>
<td>1000 mm (Joint centre to joint centre)</td>
</tr>
<tr>
<td>STANDARD LENGTH OF SAAX</td>
<td>1 m to 150 m</td>
</tr>
<tr>
<td>CUSTOM LENGTH OF SAAX</td>
<td>Over 150 m (Contact Measurand for details)</td>
</tr>
<tr>
<td>LENGTH OF PEX TUBING</td>
<td>1.5 m standard</td>
</tr>
<tr>
<td>LENGTH OF COMMUNICATION CABLE</td>
<td>15 m standard (13.5 m extends past PEX tubing)</td>
</tr>
<tr>
<td>ACCURACY OF DEFORMATION RELATIVE TO STARTING SHAPE(^2)</td>
<td>± 1.5 mm for 32 m SAAX</td>
</tr>
<tr>
<td>ACCURACY OF ABSOLUTE SHAPE(^1)(^)(^3)(^4)</td>
<td>± 10 mm for 32 m SAAX</td>
</tr>
<tr>
<td>RESOLUTION OF SINGLE SEGMENT(^3)(^4)(^5)(^6)</td>
<td>± 2 arcseconds</td>
</tr>
</tbody>
</table>

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1. Measured at 20°C, with X mark facing a consistent direction.
2. Long term measurement value based on field measurements of vertical arrays > 1 year of operation.
3. Value based on averaging 1000 frames per reading.
4. Specification is for 3D mode within ± 15° of vertical.
5. Short-term measurement ≤ 24 h.
6. RMS calculated from published noise figure of sensor (verified by Measurand Inc.) and bandwidth of system using highest AIA setting of 25,600 samples.
SAASCAN

Built for rapid deployment and repeated use. The instrument of choice for one-shot verification of the alignment of jet-grouting holes. Thick-walled 500 mm segments provide great spatial detail and resist damage.

Segment Length:
500 mm

Installation:
Vertical/Horizontal/Convergence

Applications:
Temporary
## PHYSICAL PROPERTIES

<table>
<thead>
<tr>
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</tr>
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<tbody>
<tr>
<td>SEGMENT LENGTH</td>
<td>500 mm (Joint centre to joint centre)</td>
</tr>
<tr>
<td>STANDARD LENGTH OF SAASCAN</td>
<td>0.5 m to 50 m</td>
</tr>
<tr>
<td>CUSTOM LENGTH OF SAASCAN</td>
<td>Over 50 m (Contact Measurand for details)</td>
</tr>
<tr>
<td>LENGTH OF UNSENSORIZED NEAR-CABLE END</td>
<td>8.2 m standard (Includes 330 mm Cable Terminator Segment and 7900 mm Hydraulic Hose)</td>
</tr>
<tr>
<td>LENGTH OF COMMUNICATION CABLE</td>
<td>15 m standard</td>
</tr>
<tr>
<td>ACCURACY OF DEFORMATION RELATIVE TO STARTING SHAPE&lt;sup&gt;2&lt;/sup&gt;</td>
<td>± 1.5 mm for 32 m SAAScan</td>
</tr>
<tr>
<td>ACCURACY OF ABSOLUTE SHAPE&lt;sup&gt;1&lt;/sup&gt;&lt;sup&gt;2&lt;/sup&gt;</td>
<td>± 10 mm for 32 m SAAScan</td>
</tr>
<tr>
<td>RESOLUTION OF SINGLE SEGMENT&lt;sup&gt;3&lt;/sup&gt;&lt;sup&gt;4&lt;/sup&gt;&lt;sup&gt;5&lt;/sup&gt;</td>
<td>± 2 arcseconds</td>
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DATA COLLECTION AND VIEWING

Geotechnical Observations take export files from SAASuite for use in our presentation packages, Atlas and Geodaisy. Atlas is an efficient tool for graphically presenting data from all types of instrumentation and can be used to raise alarms to real-time events. Geodaisy is Geotechnical Observations’ in-house software for analysing and interpreting the results of real-time data. It includes a wide range of tools for analysing the results from ShapeArrays.
Auto Collection / Retrieval

ShapeArray(s) --- Data Acquisition System --- SAA232 --- Wireless Comms

Auto Collection / Manual Retrieval

ShapeArray(s) --- Data Acquisition System --- SAA232

Manual Collection / Retrieval

ShapeArray(s) --- FPU --- Laptop

SAASuite
Open Data Exports
INSTALLATION SUPPORT

When complex or uncertain installation conditions face our clients, Geotechnical Observations, supported by Measurand, is able to assist with technical experts in the field. We believe that providing onsite technical advice and training gives your team a solid foundation to get valuable and actionable data from ShapeArray’s real-time deformation monitoring.

AFTER SALE SUPPORT

In-house support is provided by Measurand’s technical staff with industry experience, ready to provide assistance with your ShapeArray instrumentation. An online library and support portal make it simple to collect, process, and view your data. For situations that require closer attention, support staff are available via telephone and email.
ONE PRODUCT.
ONE FOCUS.
YOUR SOLUTION.
MEASURAND IS THE INDUSTRY STANDARD FOR REAL-TIME GEOTECHNICAL MONITORING
US ROUTE 2 LANDSLIDE

Traffic diverted before catastrophic failure
SHAPEARRAYS PROVIDE EARLY WARNING AND THEN SURVIVE MASSIVE SLIDE

Steep river banks and clay soil near highways have led to numerous slide events near Crookston, MN, over the past 50 years. In 2003, a landslide in downtown Crookston caused significant property damage, leading the Minnesota Department of Transportation (MnDOT) to investigate new monitoring solutions. The department had used traditional inclinometers, but were interested in automation and remote collection of data. MnDOT installed ShapeArrays in two roadway sections on US Route 2 experiencing stress related to erosion and soil instability.

ShapeArray data revealed that soil movements at the Crookston East site were deeper than anticipated. Experts determined that the slope was no longer creeping and a major failure was occurring. The MnDOT closed the westbound lanes of US 2 and detoured traffic on Sept. 15, 2008. Ten days later, a large progressive landslide occurred, dropping a 150 metre section of highway three metres. The slide continued over several days. ShapeArray helped engineers ensure that no members of the public were hurt during the sliding event. ShapeArray survived unprecedented deformation during and after the event. The system remains in place and provides valuable data to the MnDOT.

See more case studies at measurand.com

Reference:
Europe’s largest tailings pond demanded deep ShapeArray monitoring
SHAPEARRAY PROVIDE RISK REDUCTION FOR CHALLENGING SOIL FOUNDATION CONDITIONS

With a development capacity of over 1.1 billion cubic metres, that accepts 80,000 tonnes of tailings each day, the Żelazny Most Reservoir plays an essential role in Poland’s economic activity. When the engineers at the Żelazny Most Reservoir began to suspect that the ground beneath Europe’s largest copper tailings pond might be moving, they needed new monitoring solutions.

ShapeArray enabled monitoring at an unprecedented depth, which provided Żelazny Most Reservoir’s owners, KGHM Polska Miedz, a way to monitor slope stability and deformation in the dam foundation.

ShapeArray is part of a monitoring program at the reservoir to accommodate the tailings produced by three copper mines in the area.

See more case studies at measurand.com
Effective convergence and settlement monitoring in confined, hazardous space
REAL-TIME DATA ALLOWS DESIGN VERIFICATION AND IMPROVES WORKER SAFETY

When designers of the Crossrail tunnel underneath London’s streets encountered obstacles such as brick sewers, they installed ShapeArrays to monitor convergence and settlement. The Mid-level sewer lay just a few metres above a hand excavated cross-passage between the existing Bond Street Station and a new ticket hall on London’s busy Oxford Street.

Working with electrical instrumentation inside potentially explosive environments can be dangerous and following detailed discussions with Thames Water, it was decided that the ShapeArrays should be protected with ATEX certified conduits. Geotechnical Observations sourced suitable protective sleeves and worked closely with Thames Water and Measurand to deliver a safe and reliable system. ShapeArrays were installed around the internal circumference of the sewer to measure convergence and along the crown of the sewer to measure settlement as tunnelling occurred beneath the sewer.

ShapeArray’s low profile does not obstruct flow in tunnels and eliminates the need for workers to enter the potentially dangerous environments to collect data. The system has also been used in live railway tunnels.

See more case studies at measurand.com
ShapeArray measured retaining wall deflection, reduced construction time and costs
Whilst constructing a new £1 billion station at Tottenham Court Road in London’s West End, engineers planned five levels of temporary props to bolster and stabilize the retaining walls. Geotechnical Observations installed nine ShapeArrays vertically into the retaining walls to measure deflection. Engineers set a number of different alarms to notify staff when movement exceeded their thresholds. The data produced by the ShapeArrays allowed our engineers to help draft a Value Engineering (VE) proposal to omit a planned propping level. The data showed that forces acting on the retaining walls were within allowable tolerances without the additional prop. The client accepted the VE proposal, which resulted in significant savings to the project and eliminated 26 days of scheduled construction.

See more case studies at measurand.com

Reference:
Following the very successful use of ShapeArrays on the Crossrail project in London, contractors again turned to them for monitoring the construction of an extension to the Northern Line on London Underground’s network. On this project ShapeArrays were, for the first time, written into the monitoring specification in preference to other forms of in-place measuring equipment. Geotechnical Observations installed ShapeArrays into the vertical retaining walls for two shafts and two station boxes, as well as three existing railway tunnels. Installing instruments into live railway tunnels brought many new challenges and new methods of fixing had to be developed, but as always Geotechnical Observations and Measurand rose to the challenge.
Geotechnical Observations’ vision is to be your preferred supplier of structural and geotechnical instrumentation and monitoring services. That is why we have partnered with Measurand, who strive to design and manufacture superior monitoring products. Together we provide the customer service to match this. From sales to installation to support our joint aim is your satisfaction. Geotechnical Observations is the exclusive distributor of Measurand’s products in the UK and Ireland.

**Geotechnical Observations Ltd.**
The Peter Vaughan Building
9 Avro Way Brooklands
Weybridge Surrey KT13 0YF
info@geo-observations.com
Tel: +44 (0)1932 352040
Fax: +44 (0)1932 356375

**Measurand Inc.**
2111 Hanwell Road
Fredericton, NB
E3C 1M7
Canada
Tel: 1 (506) 462-9119

Visit us online at www.geo-observations.com and www.measurand.com