Strain Measurements on Concrete

Concrete is a porous material and generally will have a surface that is too rough to form a very thin and void-free adhesive layer between the strain gage and the concrete. For these reasons, concrete must first be sealed with an epoxy such as M-Bond AE-10. Long gage length strain gages are typically required on the surface of concrete in order to correctly strain-average over the aggregate and mortar mixture. Since concrete is a poor conductor of heat, precabled gages or gages with preattached leadwires are highly recommended.

**Step 1**
Define the Test Conditions

<table>
<thead>
<tr>
<th>Conditions to Consider</th>
<th>Your Test Conditions</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Static measurement</strong></td>
<td></td>
</tr>
<tr>
<td>One sample per second or less, steady loading</td>
<td></td>
</tr>
<tr>
<td><strong>Dynamic measurement</strong></td>
<td></td>
</tr>
<tr>
<td>Cyclical or impact loading, high frequency</td>
<td></td>
</tr>
<tr>
<td>Event duration</td>
<td></td>
</tr>
<tr>
<td>Anticipated frequency</td>
<td></td>
</tr>
<tr>
<td><strong>Installation longevity</strong></td>
<td></td>
</tr>
<tr>
<td>Short Term: Hours, days, weeks</td>
<td></td>
</tr>
<tr>
<td>Long Term: Months, years</td>
<td></td>
</tr>
<tr>
<td><strong>Environment</strong></td>
<td></td>
</tr>
<tr>
<td>Maximum temperature</td>
<td></td>
</tr>
<tr>
<td>Minimum temperature</td>
<td></td>
</tr>
<tr>
<td>Exposure (outdoors, moisture, chemicals)</td>
<td></td>
</tr>
</tbody>
</table>

**Step 2**
Ensure Appropriate Surface Preparation Materials Are On Hand

Use the recommended *surface preparation materials* for concrete:

- GC-6 alcohol
- GSP-1 gauze sponge
- 400-grit SCP-3 silicon carbide paper
- CSP-1 cotton-tipped applicator

- M-Prep Neutralizer 5A
- M-Prep Conditioner A
- PCT-3M gage installation tape
- PDT-3 drafting tape

Reference Related Documents: SEARCH our website using the document number.
11129 – Instruction Bulletin B-129; 11091 – Tech Tip TT-611
Strain Gage Installation Checklist
Concrete

Step 3
Select the Strain Sensor

Consult the Micro-Measurements team and/or review our Tech Note TN-505, “Strain Gage Selection – Criteria, Procedures, Recommendations” for detailed information about the strain gage selection process.

Step 3A: Select the Gage Series for the Temperature Range

Consider the temperature range that will be encountered during the strain measurements and select a Gage Series that meets your requirements.

<table>
<thead>
<tr>
<th>Gage Series</th>
<th>Temperature Range</th>
<th>Features</th>
</tr>
</thead>
<tbody>
<tr>
<td>CEA</td>
<td>−100°F to +350°F (−75°C to +175°C)</td>
<td>Universal, general-purpose strain gages. Large, easily soldered tabs. Precabled (Option P2) available.</td>
</tr>
<tr>
<td>C2A</td>
<td>−60°F to +180°F (−50°C to +80°C)</td>
<td>Precabled, general-purpose strain gages.</td>
</tr>
<tr>
<td>EA</td>
<td>−100°F to +350°F (−75°C to +175°C)</td>
<td>Widest range of available patterns, sizes and optional features.</td>
</tr>
<tr>
<td>EGP</td>
<td>+25°F to +125°F (−5°C to +50°C)</td>
<td>For direct embedment in concrete</td>
</tr>
<tr>
<td>LEA</td>
<td>−40°F to +180°F (−40°C to +83°C)</td>
<td>Sealed weldable strain gage for rebar</td>
</tr>
</tbody>
</table>

Step 3B: Choose the STC for Your Material

When temperature changes will occur during the course of strain measurements, self-temperature-compensation (STC) 06 is often selected for concrete.

Step 3C: Consider the Geometry

The strain gages below are popular for strain measurements on concrete. Check Super Stock for gages that are available to ship promptly. Our C2A-06-20CLW-350 is an excellent choice for aggregate ≤0.5" (13 mm) diameter.

<table>
<thead>
<tr>
<th>Type</th>
<th>Gage Designation</th>
<th>Geometry/Construction</th>
</tr>
</thead>
<tbody>
<tr>
<td>SUPER STOCK</td>
<td>C2A-06-20CLW-120</td>
<td>Linear pattern, 2-in long gage length, precabled</td>
</tr>
<tr>
<td>with Long Gage Lengths</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>C2A-06-20CLW-350</td>
<td></td>
</tr>
<tr>
<td></td>
<td>EA-06-40CBY-350</td>
<td>Linear pattern, 4-in long gage length</td>
</tr>
<tr>
<td>Concrete Embedment Gages</td>
<td>EGP-5-120</td>
<td>Linear embedment gage, precabled</td>
</tr>
<tr>
<td></td>
<td>EGP-5-350</td>
<td></td>
</tr>
<tr>
<td>Weldable Gages for Rebar</td>
<td>CEA-06-W250A-120</td>
<td>Linear pattern</td>
</tr>
<tr>
<td></td>
<td>CEA-06-W250A-350</td>
<td></td>
</tr>
<tr>
<td>Sealed Weldable Gages for Rebar</td>
<td>LEA-06-W125E-350/10L</td>
<td>Linear pattern, precabled</td>
</tr>
<tr>
<td></td>
<td>LEA-06-W125E-350/3R</td>
<td></td>
</tr>
</tbody>
</table>
Strain Gage Installation Checklist
Concrete

### Step 4
Select the Adhesive

<table>
<thead>
<tr>
<th>Adhesive</th>
<th>Conditions to Consider</th>
<th>Application Kits contain specific adhesives, surface preparation materials, and in some cases wire and coatings necessary for a successful strain gage installation on concrete.</th>
</tr>
</thead>
</table>
| M-Bond 200 Kit | For short-term applications involving bonding a strain gage to a sealed surface           | • **BAK-200 Kit**  
Contains M-Bond 200 adhesive and basic materials for surface preparation (does not include GC-6 Alcohol). Excellent for use with pre-cabled gages. |
| M-Bond AE-10   | Room-temperature curing epoxy used as a surface sealer and leveler. The preferred adhesive for bonding strain gages to a sealed surface for long-term structural monitoring | • **GAK-2-AE-10 Kit**  
Contain all materials needed to install strain gages on concrete, including solder and cable. |

Follow the instructions included with the adhesive for application and cure requirements.

### Step 5
Select Cable and Solder Terminals

Micro-Measurements offers a variety of **cable types** for gage installation on steel. For ease of installation, consider pre-cabled gages; no additional cable is required unless length needs to be extended.

<table>
<thead>
<tr>
<th>Cable</th>
<th>Conditions to Consider</th>
<th>Solder Terminals</th>
<th>Conditions to Consider</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vinyl Insulated</td>
<td>Room temperature testing</td>
<td>Bondable Terminals</td>
<td>Bonded to the test structure, these can be used as transition or anchor point for cable.</td>
</tr>
<tr>
<td>Teflon Insulated</td>
<td>Wide temperature range testing, high moisture or water immersion, and chemical resistance</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Step 6
Select a Solder

Micro-Measurements has a wide selection of **solder** for strain gage applications. Solder melt point should be at least 50°F (10°C) above the maximum operating temperature. Solder is not needed when using pre-cabled gages.

### Step 7
Select a Protective Coating

Consider the environmental conditions that the coating will need to resist and any application issues, such as:

<table>
<thead>
<tr>
<th>Environmental Conditions</th>
<th>Application Issues</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Temperature range</td>
<td>• Vertical surface</td>
</tr>
<tr>
<td>• Humidity</td>
<td>• Horizontal surface</td>
</tr>
<tr>
<td>• Chemical exposure</td>
<td>• Component sensitivity</td>
</tr>
<tr>
<td>• Localized reinforcement concerns</td>
<td></td>
</tr>
</tbody>
</table>

For a wide range of applications on concrete, **M-Coat JA** is often selected. A single tube can coat up to three strain gage installations. **M-Coat JA** has a pot life of about 2 hours after mixing.

- **M-Coat JA Kit**, one tube
- **M-Coat JA-3 Kit**, three tube

For harsh environments and extreme temperatures, refer to the **Protective Coating Selection Guide** to select the proper coating.
Strain Gage Installation Checklist
Concrete

Step 8
Select the Measurement Instrumentation

Micro-Measurements offers a wide variety of instrumentation specifically designed and optimized for strain measurement. Simple Strain Indicators are available for high-accuracy static measurements. Signal Conditioning Amplifiers accept direct strain gage input and provide a conditioned signal output in the ±10 V range. Data Systems accept direct strain gage input and provide reduced data, already in engineering units of strain and/or stress.