FSEL

PROCEDURE FOR

INSTALLATION OF STRAIN GAGES ON CONCRETE SURFACES

1. PROCEDURE OVERVIEW

This procedure is to be used for installation of bonded strain gages on concrete surfaces. It includes necessary materials and a recommended practice for surface preparation, installation, and protection of strain gages.

1.1. Student Responsibilities:

- Read and understand the requirements of this procedure
- Provide concrete for instrumentation
- Acquire all materials for strain gage installation

1.2. Staff Responsibilities:

- Read and understand the requirements of this procedure
- Assist students with installation as needed

2. EQUIPMENT AND TOOLS

There are two primary suppliers for strain gages at FSEL: Texas Measurements (http://www.straingage.com/) and Micro Measurements (http://www.vishaypg.com/micro-measurements/). Texas Measurements is an importer of gages manufactured by Tokyo Sokki Kenkyujo (http://www.tml.jp/e/). Concrete surface gage are typically purchased from Texas Measurements. The most common gage used is a PL-60-11-3LT. This gage is a 60mm long 120Ω uniaxial gage with 3m long pre-attached lead wires. Other gages and lead wire configurations are also available. More information on options can be obtained from the websites provided above.

Lead times for purchasing gages vary wildly. Occasionally gages are in stock in the U.S. and can be shipped right away. Often gages are not in stock and occasionally gages must be sent from Japan to local suppliers. In that case, lead times can be 2 to 3 months.

2.1. Materials from Texas Measurements

▪ CN adhesive ▪ PS Adhesive[1] ▪ W-1 Wax (Optional)

2.2. Materials from Micro-Measurements

▪ Gage Installation Tape (PCT 2M) ▪M-Coat A (Optional)

[1] Clear polyester casting resin can be used as an alternative material and is available at local hardware stores.

2.3. Materials Generally Available at FSEL

▪ Die Grinder with a Sanding Wheel ▪ Sandpaper ▪ Non-woven Sponges ▪Electrical Tap

▪ Digital Multimeter

2.4. Additional Materials

▪ Acetone

3. PERSONAL PROTECTIVE EQUIPMENT

▪ Safety Glasses ▪ Safety Shoes ▪ Dust Mask ▪ Rubber Gloves

4. DETAILED PROCEDURE

4.1. Mark the location(s) for gage installation.

Surface preparation will remove any marks where the gage will be applied. Alignment marks should extend well beyond the strain gage footprint.

4.2. Prepare the concrete surface for gage attachment.

4.2.1. Sand to remove the surface layer of hardened cement paste from the area to be strain gaged.

Sand the area to remove any surface dust and the thin layer of cement paste at the concrete surface. A dust mask is recommended for this step.

4.2.2. Remove all loose surface dust and debris using the pressurized air system and an air nozzle.

4.2.3. Wipe the sanded area thoroughly with acetone and a non-woven sponge.

Wipe the area repeatedly with clean sponges until no more discoloration is visible on the sponge.

Note that acetone is a highly flammable material and should be handled accordingly. Wear safety glasses to protect your eyes from acetone. Long-term exposure to acetone vapors is harmful and at a minimum, can cause headache and dizziness. Use acetone in a properly ventilated area and avoid breathing in acetone vapors.

4.3. Apply a layer of polyester resin to the cleaned concrete surface.

Polyester resin will fill any small gaps or voids to create a smooth bonding surface for the strain gage.

4.3.1. Mix the PS adhesive main agent and hardener.

The mixing instructions may have different amounts of hardener based on the expected final thickness of the polyester coating. For strain gaging, a very thin layer is desired. It may be necessary to add more hardener than recommended by the manufacturer to get a finished layer thin enough for strain gaging. Additional hardener reduces the viscosity of the mixed polyester.

4.3.2. Pour the mixed PS adhesive onto the sanded and cleaned area.

4.3.3. Place a piece of smooth plastic or silicone on top of the liquid PS adhesive.

The finished and hardened polyester layer should be very thin, very smooth, and very flat. To achieve this, place a small piece of plastic or silicone into the liquid adhesive before it sets. The plastic protective sleeve in which the gage was packaged can be utilized for this purpose. Make sure no air bubbles are trapped beneath the plastic.

4.3.4. Place strips of electrical tape to hold the plastic or silicone in place while the PS adhesive cures.

It may take up to 24 hours to cure the resin. Electrical tape will keep the plastic in place.

4.3.5. After the PS adhesive has cured, remove the plastic or silicone.

The resin should not bond to these products allowing for easy removal.

4.4. Attach the strain gage.

Attaching the gage consists of a number of smaller steps. These steps need to be done quickly and smoothly to ensure a reliable bond between the gage and the substrate.

4.4.1. Identify the top and bottom surfaces of the strain gage before removing it from the packaging.

The "top" of the strain gage has the visible metallic wires attached to it. The "top" of the gage will also have the lead wires attached to it. The printed wires are visible from the "bottom," but they will be dull in color. A view of the top and bottom of a gage purchased from Texas Measurements is shown below.

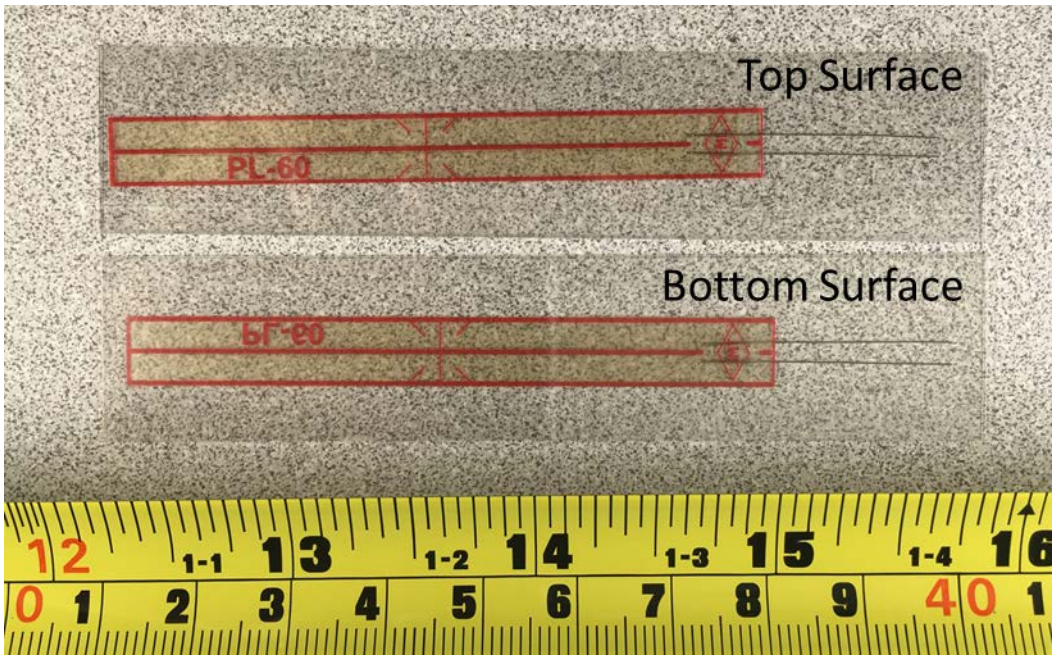

Figure 1 – Top and Bottom Surfaces

4.4.2. Remove the gage from the protective plastic sleeve and apply a piece of gage installation tape to the top of the gage.

Save the sleeve for use in applying the PS adhesive as described in Article 4.3.3.

The tape serves two purposes: 1) it allows handling of the gage without touching it and 2) it helps position the gage on the specimen for bonding. The piece of tape should be 3 to 4 in. long with the gage centered in it. The gage can be temporarily placed on a clean glass surface to apply the tape.

4.4.3. Position and tape the gage on the hardened PS adhesive.

Using the tape to handle the gage, position the gage over the cleaned area of the PS adhesive. Press the tape to the concrete to temporarily hold the gage in place. Inspect the position of the gage and reposition using the tape as needed.

4.4.4. Partially peal back the tape to expose the bottom surface of the gage.

Starting with the end of the tape near the strain gage lead wires, slowly peel the tape from the PS adhesive. Stop peeling the tape once the complete gage is expose. The

portion of the tape beyond the gage should be left adhered to the concrete to allow the gage to be returned to its previous location

4.4.5. Apply CN adhesive to the junction between the peeled back tape and the PS adhesive.

4.4.6. Slide a finger or thumb from the attached end of the tape to the free end of the tape in a smooth and continuous motion to press the gage into the adhesive and force out air bubbles.

Due to the length of the gage, it may be necessary to add additional CN adhesive as the gage and tape are pressed onto the PS adhesive layer.

4.4.7. Maintain pressure on the tape and gage for approximately 1 minute to allow the adhesive to set and harden.

Adhesive drying times are affected by ambient temperature and humidity.

4.4.8. Carefully remove the tape from the gage and concrete.

Peel back the tape from the end of the gage opposite the lead wires. The tape must be peeled back slowly and carefully to avoid damaging the gage or lead wires.

4.4.9. After removing the tape, inspect the gage for unbonded areas.

Unbonded areas will appear as air bubbles or areas of a slightly different color than the bonded areas. If the unbonded areas are on the edges of the gage, more adhesive can be added. If more adhesive is added, reapply pressure to allow the adhesive to cure.

4.5. Apply a protective coating to the strain gage and surrounding area.

One of two materials is typically used to protect concrete surface gages: M-Coat A or W-1 Wax. M-Coat A is a polyurethane coating that provides water proof coating that is resistant to most solvents. W-1 is a microcrystalline wax that provides moisture proofing and limited mechanical protection. Additional layers of either coating can be added to ensure a watertight seal.

4.6. Secure lead wire to the concrete surface.

Tape the lead wire to the concrete surface near the point where the wire connects to the gage. The tape will provide some protection to the gage if the lead wire as pulled. Also, the gage and adhesive should not be used to support the entire dead weight of the lead wire. If the wire is allowed to hang freely from the gage, it is likely that the gage or its connection to the lead wire could be damaged.

4.7. Check the electrical resistance of the gage and ensure the gage is not damaged by measuring the electrical resistance of the gage.

It is recommended that the electrical connectivity of the gage be checked as a quality control measure. If the check described below indicates a problem, the gage will likely need to be removed and replaced with a new gage.

For gages purchased from Texas Measurements, the independent wire is in a gray sheath marked with a blue stripe and the two connected, or dependent, wires are in unmarked, gray sheaths. Using a multimeter set to measure resistance, connect the independent wire to one of the probes of a multimeter. Connect one of the dependent wires to the other multimeter probe. These connections can be made by firmly pressing the bare wires to the multimeter probes. The measured resistance should approximately match the nominal resistance of the gage (120Ω or 350Ω). Perform this check on each of the two dependent wires.

4.8. Record the gage factor for the gage.

When setting up the data acquisition system, the gage factor will be needed to convert voltage measurements to strain values.

5. SUPPORTING DOCUMENTS

None.

6. REFERENCED DOCUMENTS

None.

7. RECORD OF REVISIONS

Revision	Date	Affected Pages	Description
0	2016-09-23	All	Initial Issue