ILLINOIS DEPARTMENT OF TRANSPORTATION
BUREAU OF MATERIALS AND PHYSICAL RESEARCH

PROCEDURE FOR MAKING THERMOCOUPLE BEAMS

Equipment

1. Freeze-thaw beam mold.
2. One rubber spacer.
3. One wood spacer.
4. Metal bracket(s) that goes on top to hold plastic tube.
5. Plastic tube (for end thermocouples only) to be used with item No. 6.
6. Rubber boot for wire support.
7. 21 feet of type T thermocouple wire.
8. 0.15 inch diameter stick about four inches long with sharp ends.
9. Threaded plastic tube to hold wire in place.
10. Washer tied to metal wire. Washer is used to identify and prevent loss of wire.
11. Fishing line.
12. Brass rod with grooved end (for threading fishing line through item No. 9) and blunt end (for tamping mortar in hole).

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1. Mold preparation for making an end thermocouple beam.

On the thermocouple wire (No. 7) remove the insulation around the red and blue wires three inches on one end (side A) and two inches on the other end (side B). Take approximately 0.5 inch of the blue and red insulation off the ends of the wires on side A. Take approximately 0.75 inch of the blue and red insulation off the ends of the wires on side B. Take the wires on side B and twist the metal wires together about four or five times on the bare metal. Then pull the coated wires apart to form a circle.

Use a torch to solder the wires together on the twisted end (see Figure 1). The soldered end (side B) can be checked for accuracy before making the beam by screwing the unsoldered ends (side A) to the back of the Fluke Digital Thermometer (see Figure 2) and putting the soldered end next to a thermometer in a bucket with room temperature water in it. After the beam is cast and demolded, side A is again connected to the Fluke Digital Thermometer . The room air temperature, obtained by using the Fluke Digital Thermometer, is checked with the actual air temperature to make sure the soldered end is still fused.

Figure 1. Soldering the wires.

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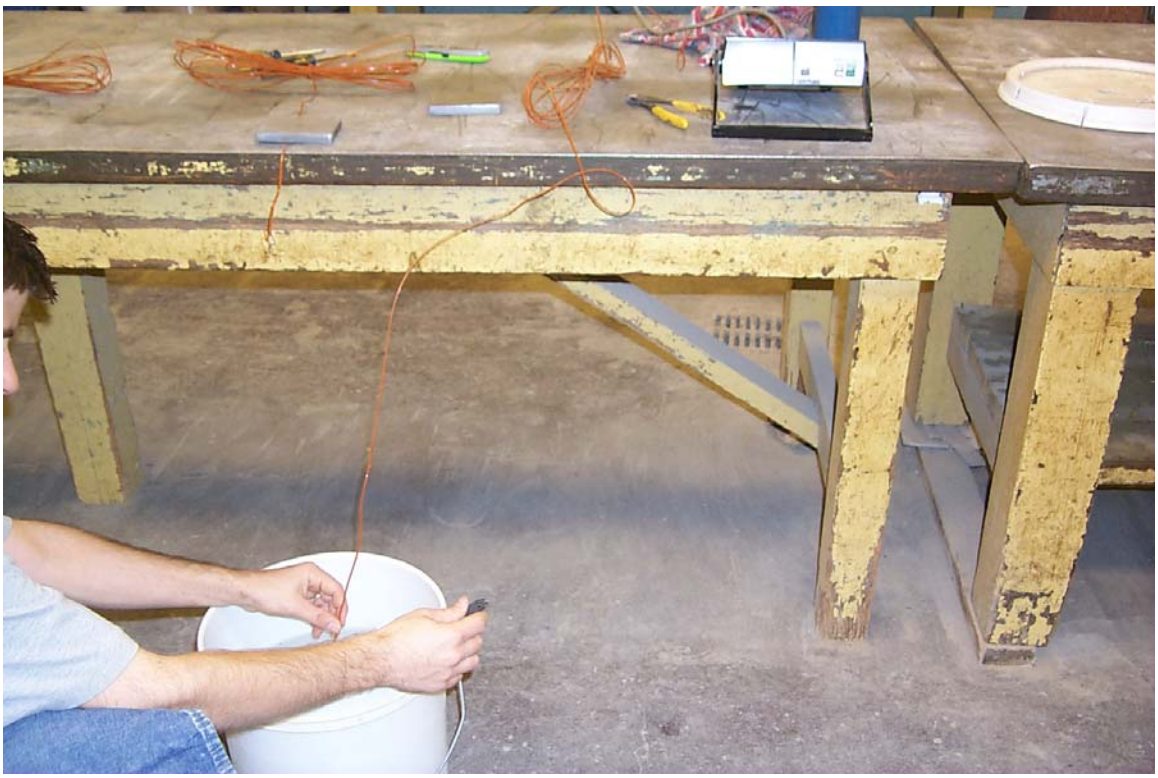
Figure 2. Testing the soldered thermocouple.



Coat the surfaces of the freeze-thaw beam mold (No. 1) with form release. Coat the rubber spacer (No. 2), the threaded plastic tube (No. 9), and the metal bracket (No. 4) with 10W30 motor oil. This can be done at anytime but is less of a mess if it is done last.

Put the wood spacer (No. 3) on one end of the freeze-thaw mold (No. 1) and then the rubber spacer (No. 2) next to the wood one. The thermocouple wire goes through the two spacers so the soldered end (side B) is in the center of the mold according to length, width, and height. The rubber spacer has a slice in it vertically from the edge to the center so it can be pulled apart to put the thermocouple wire through it. The thermocouple wire is threaded through the plastic tube (No. 5) using the non soldered end. The plastic tube (No. 5) is placed through the rubber spacer into the wood spacer as far back against the mold as the thermocouple wire will allow. The thermocouple wire comes out of the plastic tube and out of the mold. The excess wire and side A can be coiled into a pile to prevent tangling.

Put the metal bracket (No. 4) on top of the mold so the center is above where the red and blue wires come out of the insulation. Using No. 12, screw the threaded plastic tube (No. 9) down

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through the center of the metal bracket (No. 4) so that it touches the wire to ensure the soldered end is in the center of the freeze thaw beam mold (No. 1) both vertically and horizontally.

Cut a ten inch piece of fishing line (No. 11) and tie the ends together. Then stick it down through the threaded plastic tube (No. 9) and around the wire. The fishing line loop is not long enough to stay above the threaded plastic tube so use the metal wire (No. 10) to hook it so the fishing line can be pulled down in the tube. Pull it back up through the tube using the metal wire (No. 10) making sure that the tied end is on the top. Put the sharp stick (No. 8) through the fishing line and twist the fishing line with the stick so the wire is held tightly in place (see Figures 3 and 4).

Figure 3. Single thermocouple mold ready for mortar.

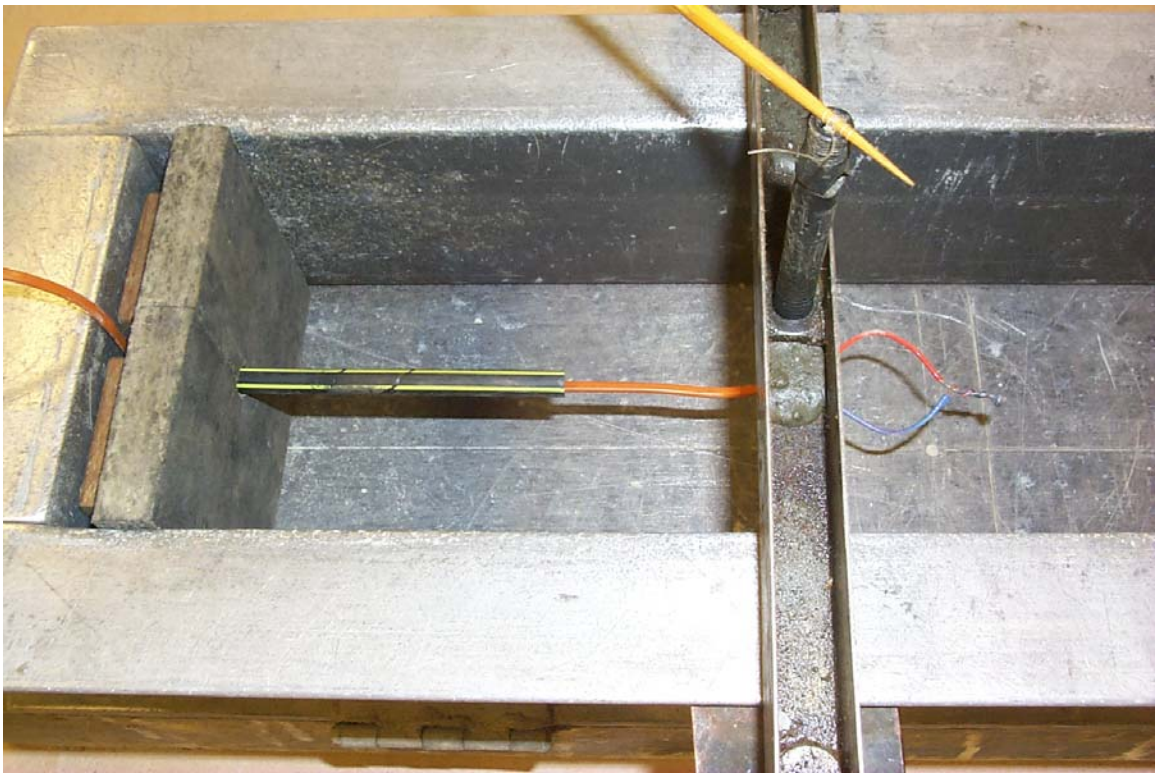

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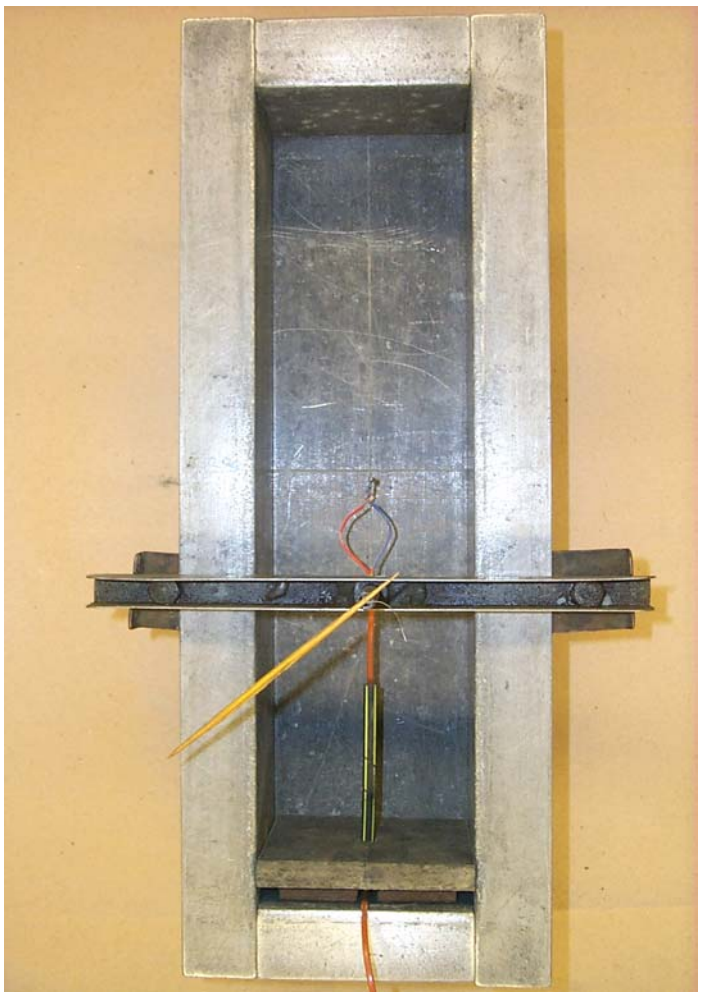
Figure 4. Top view of a single thermocouple mold ready for mortar.



2. Mold Preparation for making a center thermocouple beam.

Most of the procedure is the same as making the end thermocouple beams. There are two main differences. One difference is the use of two thermocouple wires (No. 7). The other difference is no plastic tube (No. 5) is used at the end of the beam. When using two thermocouple wires, the first wire is set the same way as previously described for making a beam with one wire (see Figures 1-4). The second wire runs underneath the first and curls back around so the fused end almost touches the first wire. A gap of ¼" (6 mm) is desired. The second thermocouple wire (No. 7) is held in place with the threaded plastic tube (No. 9) and

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fishing line (No. 11) just like the first. The two wires should be just on each side of the center of the freeze thaw beam mold lengthwise (No. 1) but not touching as previously mentioned (see Diagram 1 and Figure 5). The plastic tube (No. 5) on the end should not be used because when two wires stick out of the beam together they do not seem to break easily.

Diagram 1. Cross-sectional horizontal sketch of double thermocouple beam.
("X" is the center of the beam both vertically and horizontally.)

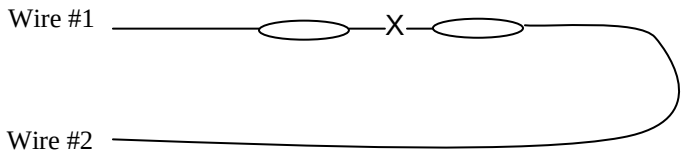
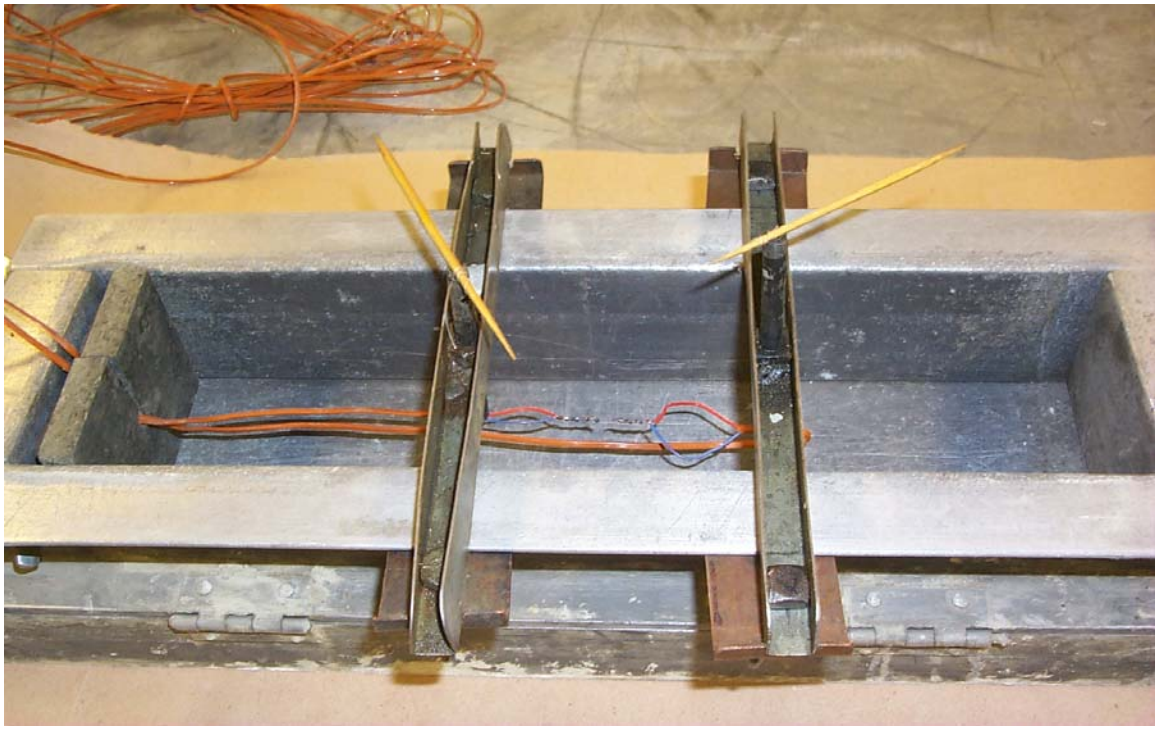


Figure 5. Double thermocouple beam ready for mortar.



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3. Mortar mixing procedure.

Mix the mortar first thing in the morning using the 1.75 cubic foot Lancaster pan mixer. For an example of a thermocouple mix design, refer to S:\concrete\excel\Mixes\2010 Mixes\CN10Q6. This mix may need to have the amount of air-entraining admixture (AEA) solution, High-Range Water Reducer, or the water changed to get the desired effect. The air content shall be 5 to 8 percent and the slump should be around four inches so the mix will be fluid enough to be consolidated with a metal spatula.

Mix for three minutes, rest for three minutes, and then mix for two minutes. Put the mortar in the freeze thaw beam molds (No. 1) carefully so you do not disturb the thermocouple wire (No. 7). Fill the mold half way and then use a metal spatula to spade the edges and throughout the mold to consolidate the mortar. Do the same for the second layer. Put the mold on the vibrating table for two or three seconds. Then strike the mold off with a metal trowel or metal spatula. After the beams are struck off, put the moist burlap and plastic over the beams to cure.

In mid to late afternoon uncover the molds and cut the fishing line. Pull the fishing line out and twist the threaded plastic tube until it comes out (No. 9). Then remove the metal bracket (No. 4).

Use the following mix to fill the hole that was left from the tube:

369 grams of sand
293 grams of cement
80 grams of water
2 cc of air-entraining admixture (AEA) solution (10% admixture (MBVR) and 90% water)
4 cc of High-Range Water Reducer (Daracem 19)
May add more water or High-Range Water Reducer to make mix more fluid.

(This is mixed in the Hobart five quart mixer.)

Use a brass rod (No. 12) blunt end to tamp the mix into the hole a little at a time. When the hole is filled, strike it off with a metal spatula. Put moist burlap and plastic back over the freeze-thaw beam molds. The next day demold the beams. Mark each beam with the date that they were made and put them in the moist room until needed. Each beam should stay in the moist room for a minimum of two weeks. Typically they are in the moist room for a year, because the longer they cure the better.

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4. Putting on the rubber boots.

After at least two weeks of curing, take the single thermocouple beams out of the moist room to put the rubber boot (No. 6) over the plastic tube (No. 5). Run the thermocouple wire (No. 7), side A, through the rubber boot (No. 6) until the rubber boot hits the plastic tube (No. 5), making sure that the flat side of the rubber boot is facing the beam. Put silicone around the base of the plastic tube (No. 5) and push the rubber boot (No. 6) tight up against the beam. Then put silicone in and around the end of the rubber boot (No. 6) to help keep water out. This should be done in the morning so the molds can be left out in the lab for about six hours under wet burlap and plastic so the silicone can dry before it is placed back in the moist room.