5.9.70 METHOD FOR TESTING POLYMER OVERLAYS FOR SURFACE PREPARATION AND ADHESION (Kansas Test Method KT-70)

1. SCOPE

This method covers the test procedure used to measure the tensile rupture strength between hydraulic cement concrete and polymer concrete overlays. This test procedure may involve hazardous materials, operations, and equipment. Follow all manufacturer suggested safety precautions when performing the test. This test is similar to ACI 503R, Appendix A, of the ACI Manual of Concrete Practice.

NOTE: “Polymer Overlay” represents the complete system; polymer adhesive and aggregate bonded to the concrete bridge deck.

2. REFERENCED DOCUMENTS

2.1. ACI Manual of Concrete Practice 503R, Appendix A “Use of Epoxy Compounds with Concrete”

3. APPARATUS

3.1. A dynamometer with a minimum capacity of 2000 lbf (1000 kg).

3.2. A mechanical testing device for pulling a bonded pipe cap in tension as shown in ACI 503R, Appendix A, of the ACI Manual of Concrete Practice. See Figure 1 below.

3.3. Core drill with a 2 inch (50 mm) inside diameter diamond tipped core barrel.

3.4. A standard 1 1/2 inch (37 mm) diameter pipe cap, where the bottom surface has been machined smooth, flat, and shoulder cut to provide a 2 inch (50 mm) diameter bonding surface. The surface of the pipe cap should be textured to provide good adhesion to the adhesive. This may be achieved by sandblasting, scoring or any method that produces a roughened bonding surface.

3.5. A rapid curing adhesive with strength and viscosity properties suitable for bonding the pipe caps to the overlay. A high viscosity, rapid setting epoxy with a pot life of 3 to 25 minutes is recommended.

3.6. Ruler or measuring device.

3.7. Small propane torch (optional).

3.8. Surface and internal thermometers.

3.9. Duct tape.

Note: Test equipment for this procedure is available in other forms and may be used with the approval of the Engineer.

4. PREPARATION OF TEST PATCHES

4.1. Select 1 1/2 foot x 3 foot (0.5 m x 1.0 m) areas of the bridge deck for the polymer concrete test patches. The test patches should cover various surface conditions found on the bridge deck. Typical
surface conditions tested should include areas in the wheel paths, in the area between wheel paths and in other areas that represent nominal as well as the worst surface conditions.

4.2. Clean test patch areas by the same method to be used to prepare the entire deck. Remove all loose disintegrated concrete, dirt, paint, oil, asphalt, laitance carbonation and curing materials from patches and other foreign material from the surface of the deck that can interfere with the curing or adhesion of the overlay. Cleaning is usually indicated by a significant change in the color of the concrete and exposing coarse aggregate particles.

4.3. Tape off an area 1 1/2 foot x 3 foot (0.5 m x 1.0 m) using duct tape. Measure and record the temperatures of the air, deck surface, polymer components and aggregate.

4.4. Mix the polymer components as prescribed by the manufacturer using the same equipment, timing, and sequence of operation as will be used when placing the overlay on the full deck surface.

4.5. Collect a 2 ounce (50 ml) sample of the mixed polymer and measure and record the polymer gel time. The gel time is the time interval between the initial mixing of the polymer and the formation of a gelatinous mass in the center of the sample.

4.6. Accurately prepare sufficient quantities of the polymer mixture for each test patch. Place the polymer on each 0.5 square yard (0.5 sq m) prepared test area. Spread the polymer with a notched squeegee in the same manner as on the full deck surface. Apply the polymer uniformly without puddling. Apply the dry overlay aggregate on each test patch at the same rate as specified in Contract Documents.

4.7. Allow the polymer to cure as required to allow sweeping or vacuuming without damaging the surface (curing time varies according to temperature). Curing of the first course can be checked by placing thumb on the aggregate and applying pressure. If the aggregate moves, curing has not been sufficient. See Table 1 for typical minimum cure times.

4.8. Remove excess aggregate.

4.9. Accurately measure sufficient quantities of the polymer mixture for each test patch. Place the polymer on the first course of each 0.5 square yard (0.5 sq m) test area. Spread the polymer with a notched squeegee in the same manner as on the full deck surface. Apply the polymer uniformly without puddling. Apply the dry overlay aggregate on each test patch at the same rate as specified in Contract Documents.

4.10. Allow the polymer to cure as required to prevent damage from traffic. See Table 1 for typical minimum cure times.
4.11. Remove excess aggregate

### TABLE 1

**TYPICAL POLYMER CONCRETE OVERLAY CURE TIMES.**

<table>
<thead>
<tr>
<th>COURSE</th>
<th>AVERAGE TEMPERATURE OF OVERLAY COMPONENTS, °F (°C)</th>
<th>MINIMUM CURE TIME, hrs.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>55-59 (13-15) 60-64 (16-18) 65-69 (19-21) 70-74 (22-23) 75-79 (24-26) 80-85 (27-29) 85+ (29+)</td>
<td>1 2 3 2.5 2 1.5 1</td>
</tr>
<tr>
<td>1</td>
<td>5 4 3 2.5 2 1.5 1</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>8 6.5 5 4 3 3 3</td>
<td></td>
</tr>
</tbody>
</table>

5. **PROCEDURE**

5.1. Using a diamond tipped core barrel, drill through the polymer overlay and into the concrete surface to a depth of 1/2 inch (13 mm). The dimensions of the core barrel must be such that the resulting concrete core is 2 inches (50 mm) in diameter. Do not use water for the coring operation.

5.2. Vacuum or blow the dust from around the core. Bond a 1 1/2 inch (37 mm) pipe cap that has been machined to have a flat bottom surface of 2 inches (50 mm) in diameter, to the cored overlay disk. The adhesive used to bond the pipe cap to the overlay should be a rapid curing adhesive with a minimum working life of 3 minutes. Apply a small amount of adhesive to both the pipe cap surface and the cored disk. Do not allow any adhesive to flow over the edge of the cored disk or down into the cored area. If this occurs, do not record the test result, core an alternate area and perform another test. To decrease the curing time of the epoxy adhesives, heat may be applied to pipe cap by means of a small propane torch. Do not heat the cored disk directly! Monitor the temperature of the pipe cap. Do not allow the cap temperature to exceed 120°F (49°C).

5.3. It is of the utmost importance that the tensile rupture equipment and dynamometer be aligned with the extended axis of the pipe cap to give accurate test results. To ensure the alignment of the apparatus alignment the use of a template is advised.

5.4. Screw the lower threaded hook into the cap. Place the testing apparatus over the pipe cap and align with the cored disk.

5.5. Attach the dynamometer to the upper and lower hooks. Set the load indicator on the dynamometer to zero. Check the date of calibration on the dynamometer. It must have been calibrated within the last 12 months.

5.6. Apply a tensile load at the rate of 100 ± 10 pounds (45 ± 5 kg), every 5 seconds.

5.6.1. Record the load for each test core to the nearest 10 lbf (5 kg).
5.6.2. Record the type of failure for each test core and percent failure in the concrete over the test area for Type 1 and Type 2 failures.

There are five types of failures:

- **Type 1** - Failure in the concrete at a depth greater than or equal to 1/4 inch (6 mm) over more than 50% of the test area.
- **Type 2** - Failure in the concrete at a depth less than 1/4 inch (6 mm) over more than 50% of test area.
- **Type 3** - Separation of the polymer overlay from the concrete surface.
- **Type 4** - Failure within the polymer overlay.
- **Type 5** - Failure of the test adhesive.

A properly applied polymer overlay on a properly prepared surface typically will result in a failure in the concrete (Type 1).

5.7. Perform a minimum 4 pull-off tests on each 1 1/2 foot x 3 foot (0.5 m x 1.0 m) test patch.

5.8. Repair the hole created by the tensile rupture strength test with a mixture of the polymer and aggregate used in the overlay.

6. **CALCULATIONS**

6.1. Use the 3 highest values to calculate the Tensile Rupture Strength for the test patch as noted below.

6.1.1. For Type 1 failures:

- Tensile Rupture Strengths less than 250 psi (1.7 MPa) will not be used in the average tensile rupture calculation.
- Should one pull out fail below 250 psi (1.7 MPa) the test result will be the average of the two remaining pull-off tests.
- Should two pullouts fail below 250 psi (1.7 MPa) the test result will be the Tensile Rupture Strength of the one remaining test.
- A failure in the concrete below 250 psi (1.7 MPa) indicates weak concrete, not poor overlay bond.

6.1.2. For Type 2, 3 or 5 failures use the average of the three highest pull-off values to determine the Tensile Rupture Strength.

6.1.3. Type 4 failures will not be accepted or used in calculations.

6.2. Determine the Tensile Rupture Strength for each test core using the following equation:

\[
TRS_x = \frac{P}{A}
\]

- \(TRS_x\) = Tensile Rupture Strength for one test core.
- \(P\) = Load (Dynamometer)
- \(A\) = Area of cored disc, verify the area prior to performing the calculations.

6.2.1. This value will be recorded as the result for one test core. Record the result to nearest 10 psi (0.1 MPa).
6.3. Determine the average Tensile Rupture Strength for each test patch using the following equation.

\[ TRS_{avg} = \frac{TRS_1 + TRS_2 + \ldots + TRS_n}{n} \]

\[ n \] = number of test cores

7. REPORT

7.1 This value will be recorded as the result for one test patch. Report the result to nearest 10 psi (0.1 MPa).

Figure 1