

Polyurea Waterproofing of Boston Subway Tunnels



The Massachusetts Bay Transit Authority, locally known as the MBTA, is responsible for keeping the subway or “T” running efficiently in Boston. Over the past 10 years, Boston has been engaged in the ambitious Central Artery or “Big Dig” project. The project is to bury the main expressway running through downtown Boston, and build another automobile tunnel connection to Logan airport. An aside to the Central Artery project is to build a new subway connection to Logan airport.

The tunnels are being built in three binocular sections. Two tubes are 230 feet long, 37 feet wide and 23.25 feet high. The base slab of all three tunnels has a positive-side waterproofing of ¼ inch thick, welded steel plate.



Two of three binocular immersed tube tunnels.

The walls and roof of all three sections received a 100 mil thick, seamless PCS-355 polyurea applied over PCS-30 penetrating concrete primer. Both products are manufactured and supplied by Polyurea Coatings Systems, Inc. of Stafford, Texas. When the polyurea work is finished, a 3-inch thick protective mortar layer will cover the roof waterproofing, and will be the bearing base of an additional 3.08 feet of concrete roof ballast.

When the tunnels are finished, they will be sealed with watertight doors and equipped with an elaborate ballast system. The drydock where the tunnels are built will then be flooded and the tunnels floated to their final placement location.



The cast-in-place concrete tubes were built and stored in an old Navy dry dock for over a year. The tubes were subject to the elements and developed some shrinkage cracks in the roof slabs. Cracks were routed-out, injected with epoxy and caulked.

When the epoxy crack injection and caulking operation was complete and the materials were cured, the PCS-355 polyurea application continued.

Bugholes form as air pockets are vibrated to the surface of the concrete against the steel form. When the forms are removed, the voids are quite evident. To fill the voids, the wall was “rubbed” with a mixture of Portland cement, fine sand and a latex binder.



One of the problems with mass cast, steel-formed concrete is surface “bugholes” and voids.

The concrete needs to be free of dust and dirt. The best way to accomplish this is by high pressure water blasting. Pressures of 3,000 psi and higher are sufficient. When the cleaned section is dry, the next step is priming.

Since there are two substrates; steel and concrete, two different primers are used. PCS-30 is a low viscosity, 100% solids penetrating primer. PCS-40 is a 100% solids, iron oxide containing corrosion resistant steel primer. PCS-32 is a low temperature version of PCS-30 concrete primer, that can be used between 35° F. to 60° F. Depending on the ambient and substrate temperature, the primers will be tack-free and ready for polyurea coating in 8 to 12 hours.

PCS-355 is a 100% solids polyurea that conforms to the definition of



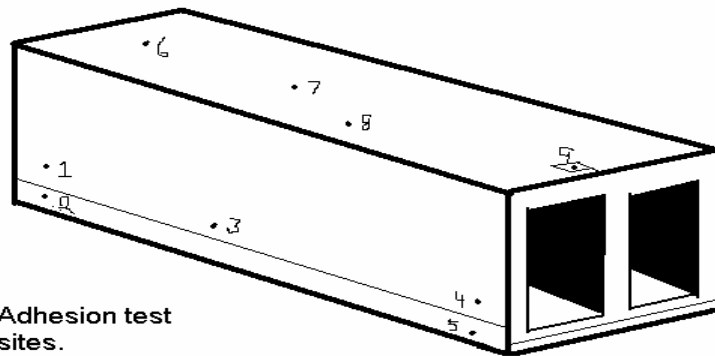
the Polyurea Development Association (PDA). Because PCS-355 is 100% solids, application thickness can be built up in a single application session. Here the specified thickness is 100 mils. The PCS-355, as with all true polyurea, is isocyanate based and must be used with proper personnel safety equipment.

Quality assurance and quality control were achieved through two tests. First is thickness testing using a Panametrics ultrasound test equipment. The second was an Elcometer adhesion test, recognized in ASTM D-4541. Thickness tests were done according to specification every 100 square feet. Adhesion tests were done a minimum three per surface. For example, three tests on the roof slab and three tests on each wall. Preliminary adhesion tests are recorded in Table 1.

PCS-40 steel primer being applied to base plate. When the primers are "tack-free", the PCS-355 100% solids polyurea is ready for application



Table 1. Adhesion test results. Tube 1.



Adhesion test sites.

Location of pull test. Results of test. Description of failure.

Site # 1.	400 psi	Cohesive failure.
Site # 2.	950 psi	On steel plate. Adhesive failure.
Site # 3.	550 psi	Cohesive failure.
Site # 4.	600 psi	Cohesive failure.
Site # 5.	600 psi	On steel base plate. Adhesive failure.
Site # 6.	650 psi	Adhesive failure.
Site # 7.	800 psi	Adhesive failure.
Site # 8.	850 psi	Adhesive failure.
Site # 9.	850 psi	On steel plate. Adhesive failure.

At this writing the adhesion tests are not yet complete, but the initial results are very promising.