INSPECTION AND REPAIR PROCEDURES FOR PRECAST VAULTS AND MANHOLES

Figure 1. Vault Repaired with Epoxy Injection

1. Scope

This Guideline covers the inspection and repairs of cracks and/or spalling in precast vaults, manholes, and other similar structures. It shall apply to all new precast concrete vaults, manholes, and handholes with a dimension (length, width, depth) of 4 feet or more that are installed for use by Seattle City Light.

2. Background

A main source of strength in precast concrete structures is provided by the rebar (reinforcing steel). The principal component of the reinforcing steel is iron which has a persistent tendency to return to its natural state, generally iron oxide, or rust. Whenever an excessive amount of heat or moisture is present, the rebar will rust at a rapid rate. The presence of admixtures, such as calcium chloride, and moisture increases the probability of rebar rusting.

When the rebar rusts, it begins to lose strength, but more importantly the rust occupies a much greater volume than the iron from which it came. The rust exerts expansion pressures exceeding the ability of even the strongest concrete to resist. The result is cracking and, if corrosion continues, concrete will spall off. Such spalling is frequently accompanied by leaching of rust to the concrete surface, leaving unsightly stains. Remedial action must be taken so that progressive deterioration does not ultimately threaten the structure's adequacy.

As stated above, structures that have high humidity and excessive heat are very likely to eventually start to crack or spall.

A spall is a fragment of concrete detached from the larger mass by a blow, by action of weather, or by pressure or expansion within the large mass. In the case of vaults, it is frequently caused by expansion that accompanies the corrosion of reinforcing steel.

3. Inspections

3.1 Precast Vaults and Manholes (except Vault/Manhole roof)

Cracks less than 0.012″ wide are not an immediate source of concern, unless there are multiple cracks in one area. Cracks 0.012″ wide or greater, or spalling 0.375″ deep or greater are of concern, especially in high moisture vaults or where excessive heat is present. These cracks and spalls shall be repaired. Any cracks or spalling that make the reinforcing steel visible shall be repaired immediately. If a crack is 1/8″ (0.125″) wide or more, SCL Civil Engineering should be called to determine if the entire structure or roof should be replaced, or to provide detailed procedures for major repair.

Generally, the precast manufacturer will look at the defect and provide an opinion regarding repair. Precast vaults and manholes shall have the minimum concrete cover over rebar as specified in Table 3.1. Where insufficient concrete cover is found, the supplier should be notified.

Table 3.1, Minimum Concrete Cover over Rebar

Type of Rebar	Minimum Depth of Cover, in.
Main reinforcing steel	1-1/2
Stirrups and Ties	1

It should be noted that any structure under one year old (covered by warranty) that has cracks or spalling, as described in SCL Material Standard 7201.00, should immediately be brought to the attention of the manufacturer and installing contractor.

Vaults being inspected should be tested by hammering the walls and roofs. A hollow sound will indicate loose or delaminated concrete.

3.1 Precast Vaults and Manholes (except Vault/Manhole roof), continued

Prior to replacing any defective concrete, the manufacturer should be notified in order to determine if he is liable for any portion of the repair.

3.2 Inspection – Vault/Manhole Roof

Any cracks greater than 0.012″ are a concern when they appear in vault roof, especially if the roof is in a heavy traffic area. The manufacturer and/or SCL Civil Engineering should be contacted for advice on replacement. Cracks 0.062″ wide or greater in a vault roof indicate a faulty cover and require the replacement of the entire roof.

4. Repair Procedure – Cracks

4.1 General

Cracks shall be repaired by injecting epoxy grout under pressure into the crack. The procedure for preparation and application of the epoxy injection shall be in accordance with the epoxy manufacturer's recommendations and as described below:

a. Cracks to be filled shall be cleaned of dust, silt, and any other material that would impair bond of the epoxy to the concrete. For small cracks, cleaning shall be done by vacuuming. Large cracks may be blown out with compressed air.

b. Suitable fixed injection ports shall be established along the cracks at intervals not less than the thickness of the concrete being injected. At the end of a crack, the first port shall be about half this distance from the end.

c. The surface of the crack between ports on both faces of the structure, if they are accessible, shall be sealed with tape or other temporary surface sealant which is capable of retaining the epoxy adhesive in the crack during pressure injection and until the epoxy has hardened. Sealing tape and/or temporary surface sealant should remain in place until the epoxy has hardened.

d. Epoxy adhesive shall be pumped into the cracks through the injection ports. The pump, hose, injection gun, and appurtenances shall be capable of injecting the epoxy at a sufficient rate and pressure to completely fill all designated cracks. The temperature of the concrete shall be not less than 45 deg F at the time the epoxy is injected.

e. Before starting injection work and at hourly intervals during injection work, a sample of mixed epoxy shall be taken from the injection gun. If these samples show any evidence of improper proportioning or mixing, injection work shall be suspended until the equipment or procedures are corrected.

4. Repair Procedure – Cracks

4.1 General, continued

f. The epoxy adhesive shall be forced in to the first port at one end of a crack until adhesive runs in substantial quantity from the next adjacent port. The first port shall then be sealed and injection started at the next port where the epoxy has just begun to show. Injection shall then continue from port to port in this manner until the crack is fully injected. For slanting or vertical cracks, pumping shall start at the lower end of the crack and progress upward. Where approximately vertical and horizontal cracks intersect, the vertical crack below the intersection shall be injected first. For horizontal structural elements, the crack shall be injected from bottom of the element, filling upward.

4.2 Injection Equipment

a. Automatic pressure injection systems shall contain positive displacement pumps with variable feed rate to ensure components are mixed at the correct ratio.

b. The recommended injection pressure for epoxy injection shall be 10 to 15 psi at the beginning of the injection at each injection location. The pressure may be gradually increased to 20 to 25 psi if the injection progresses too slowly. The maximum injection pressure shall not exceed 75 psi.

For best results, it is recommended that low injection pressure, in the range of 10 to 25 psi, and slower injection progressive speed be maintained at all times. This can be verified with the use of a pressure gauge located on the discharge side of the mixer.

c. Transparent reservoirs shall be used to verify that the ratio of the components mixed is in accordance with epoxy manufacturer's recommendations. Metering systems shall be used to ensure mixing accuracy is within 2%.

4.3 Material

a. Epoxy shall be a two-component, waterproof system specifically manufactured for use in filling cracks by means of pressure injection. All epoxy resin shall conform to the requirements of the American Society for Testing and Materials (ASTM) Standard Specification for Epoxy Resin Base Bonding Systems, ASTM C 881-02.

b. The following are approved epoxies and suppliers:

Epoxies	Manufacturer
Ceilcote 747R Repair Grout	Ceilcote, a division of International Protective Coatings
Sikadur 52 Injection Resin	Sika Corporation

Other materials may be submitted for approval.

5. Repair Procedure – Spalls

5.1 Preparation

a. Remove all loose material to sound concrete. The perimeter of the prepared area should have perpendicular edges with a minimum depth of 1/8″.

b. Concrete shall be chipped to a minimum clearance of one inch all around corroded reinforcing bars. The exposed bars shall be cleaned of corrosion.

Figure 2. Mortar Patch for Spall Repair

c. Existing concrete surface at the repairing area shall be roughened to a minimum depth of 1/8″ prior to patching.

d. If the diameter of the rebar is reduced by 1/16″ or more, additional reinforcement shall be installed. Precast manufacturers should be contacted for installation details.

5.2 Patching

Overhead grout patches shall be applied in layer not to exceed 1/2″ in thickness.

5. Repair Procedure – Spalls, continued

5.3 Materials

All material shall be applied in accordance with grout manufacturer's recommendations.

Nonshrink Grout	Manufacturer
Masterpatch 95 Repair Mortar	BASF
Five-Star Nonshrink Grout	Five Star Products, Inc.
Sika Top 122 and 123 Repair Mortars	Sika Corporation

Other Nonshrink grouts may be submitted for approval.

6. Record of Repair

Each area where Epoxy injection repair was done by the supplier/installing contractor shall be stamped with the label "Epoxy Injected, Inspected by Supplier/Installing contractor Name".

7. References

224.IR-07; "Causes, Evaluation, and Repair of Cracks in Concrete Structures"; American Concrete Institute

C881; "Standard Specification for Epoxy-Resin-Base Bonding Systems for Concrete"; ASTM; 2002

Detter, Chris; SCL Standards Engineer, subject matter expert and originator for U2-6/NVH-20 (chris.detter@seattle.gov)

Ng, Sharon; SCL Senior Civil Engineer, subject matter expert for U2-6/NVH-20