Evaluation of Concealed Waterproofing Membranes on Concrete Structures

By Scott B. Harrison, PE

The evaluation of concealed waterproofing membranes on concrete structures is not an easy task. Sufficient information about the waterproofing system, the underlying structure, and the owner's long-term intentions for the property must be obtained and evaluated to provide effective and economical rehabilitation options.

There are many types of waterproofing systems that are used on concealed concrete structures. Most in service today include one of the following types:

- Fully adhered, cold-applied, liquid membranes (urethane, modified asphalts);
- Fully adhered, hot-applied, liquid membranes (rubberized asphalt);
- Fully adhered, hot-applied, built-up or reinforced membranes (asphalt, rubberized, coal tar);
- Torch grade, modified asphalt composite roll membranes (modified asphalt/reinforcing sheet);
- Cold-applied, composite sheet membranes (rubberized asphalt/polyethylene sheet); and
- Loose-laid, sheet membranes (EPDM, PVC, butyl).

Each of these membrane systems has advantages and disadvantages associated with it.

History of the Membrane and Structure

The evaluation should start by reviewing the history of the structure and waterproofing system. This should include a review of the available pertinent construction drawings to determine:

- Use of the structure: parking garage, terrace with planters, and tennis courts;
- Type of structural construction: cast-in-place, precast, composite (steel and concrete), and asphalt pavement;
- Age of the structure;
- Type of waterproofing system;
- Design load information;
- Flashing details; and
- Drainage of system.

Additionally, the building management personnel should be interviewed and the building management files reviewed to determine:

- Leak history: extent and locations;
- Previous maintenance, repair and/or replacement of the membrane;
- Owner's intention for the property: long-term or short-term ownership;
- Owner's budget; and
- Tenant/resident complaints.

Test Holes to Determine Existing Conditions

A sufficient quantity of test holes should be opened to reveal the existing construction and condition of the waterproofing system. This work should be performed by a contractor who is qualified to repair the waterproofing membrane system, as well as the material covering the

Fig. 1: Waterproofing membranes on concrete structures may be concealed by pavers, steps, masonry walls, planters, and many other coverings

Fig. 2: Test holes should be performed and repaired by a qualified contractor

Fig. 3(a) and (b): Test holes should be performed at flashing detail locations, such as deck drains, perimeter walls, and transition areas (steps)

waterproofing. Test holes should be made at a minimum of the following locations:

- Typical field conditions of the membrane: at least one hole at each type of covering (pavers, soil, stone, cast concrete);
- Deck drains;
- Structural expansion joints;
- Perimeter walls;
- Structure penetrations: electrical conduit, duct work, and plumbing lines; and
- Severe leak locations that do not coincide with one of the above.

Typically, the waterproofing membrane is at the bottom of the test holes and lying directly on top of the structure. Cutting and removing sections of the membrane will assist in determining the:

- Condition and estimated useful life of the membrane material;
- Proper/improper installation of the membrane and flashings;
- Quality of adhesion to the substrate;
- Water tightness of the membrane at the test hole location; and
- Localized condition of the underlying structure.

Additionally, gathering information about the materials over the top of the membrane will be critical in determining the rehabilitation requirements and construction cost estimates. This information would include:

- Type and thickness of the materials covering the membrane;
- Drainage of the overlying materials; and

Fig. 4: Test cuts in the membrane assist in determining the existing condition and estimated remaining useful life of the membranes

- Protection or lack of protection of the existing membrane.

Laboratory testing of the membrane and flashing should be performed to determine whether asbestos-containing materials were used in the installation of the waterproofing membrane system. The removal and proper disposal of these materials may result in increased construction costs.

Additionally, laboratory testing can be performed on the membrane to assist in determining the existing condition, estimated remaining useful life and other information.

Leak Survey and Water Testing

A leak survey is best performed during a typical or heavy rainfall to observe the extent and severity of the leakage through the concrete structure. The leak locations and types should be marked on a floor plan for future reference. The leak survey data can be compared with leak information provided by the building management.

If adequate rainfall does not occur during the condition survey period, a water test can be performed to simulate a rainfall. Garden sprinklers, soaker hoses, and building landscape sprinkler systems can be used for the water test.

Additional isolated and controlled water testing can be performed at specific locations to determine the actual source of the leakage. Water testing of isolated locations should always start from the bottom and work upwards, typically spending 15 to 30 min at each location until a leak occurs. The time spent at each location will vary depending on the size of the area being tested and the quantity of spray. For example, when water-testing a leak occurring at a masonry wall, water should be sprayed and moved as follows:

- At the base of the flashing to the membrane juncture;

Fig. 5: Exposing the underlying concrete structure can reveal deteriorated concrete conditions

Fig. 6: Ultimately, the building owner may decide to perform spot repairs on the membrane system until the building can be sold or money for complete replacement can be budgeted

- On the base flashing;
- On the counter flashing; and
- On the masonry.

Some isolated water tests may only require a bucket of water.

Evaluation of the Findings and Rehabilitation Options

The main purpose of the survey is to determine the existing condition and remaining useful service life of the waterproofing membrane. Can the existing membrane be effectively and economically repaired at spot locations, or is the existing membrane completely deteriorated and in need of removal and replacement? Ultimately, the owner may decide to do the least expensive fix if that option will take care of the leaks until the building is sold.

The most critical factor to remember in the design of concealed waterproofing rehabilitation is that the cost of the waterproofing membrane is the least expensive part of the construction. Most toppings, for example, cast-in-place concrete, pavers, and planters, are much more expensive than the waterproofing system. The designer and owner should select the most effective waterproofing membrane for the long-term integrity of the concrete structure it will protect.

One factor frequently overlooked during the evaluation of concealed waterproofing systems is what is happening to the concrete structure under the membrane. Following the removal of a deficient and leaking membrane on a cast-in-place parking garage, some may be surprised by the extent of deteriorated concrete on the top surface of the slab.

Adequate protection of the membrane is required to preclude damage from the initial placement of the topping materials, by future replacement of the topping materials, and by the future repair of the waterproofing system. Positive drainage to deck drains at the membrane level is critical to keep water off the waterproofing system to the greatest extent possible.

Typically, enough information can be obtained from the evaluation to provide design drawings and specifications for rehabilitation of a concealed waterproofing system. However, additional test cuts will provide more information and minimize the potential for hidden conditions after the start of construction.

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