INVESTIGATING AND REMEDIATING LEAKS IN BELOW-GRADE STRUCTURES AND UNDER PLAZAS

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ABSTRACT

The protocol for investigating leaks in basements is not the same as that used for leaks in roofs. Although the initial procedures are similar – obtaining background data, conducting a leak survey, and observing pertinent conditions – for below-grade structures, there are significant differences.

This paper discusses the investigation procedures and reviews several of the more common causes of water infiltration into basements. These causes can be a result of a waterproofing system failure, structural failure of the foundation or slab, or an increase in hydrostatic pressure.

Recommendations are offered for alleviating water pressure by modifying above-grade building components, altering topographical elements, and the use of internal and external drains. Various techniques will be discussed for stopping water infiltration, including the application of negative-side waterproofing materials, and injecting grouts and chemicals in the soil around the foundation walls, under slabs, behind walls, and into leaking cracks and joints.

SPEAKER

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INTRODUCTION
This paper discusses methodology for investigating the cause of leaking in below-grade habitable spaces. It provides recommendations for alleviating water pressure by altering above-grade components; draining, pumping and stopping water infiltration by injection of chemicals in the surrounding soil and in cracks and joints in and behind foundations and slabs.

INVESTIGATION METHODOLOGY
The processes of investigating and stopping leaks in basements will be familiar to building pathologists who use the same protocols for resolving roof leaks.

ACCUMULATE HISTORICAL AND OTHER PERTINENT DATA
• Obtain and review original construction drawings; research records of unusual climatic events; check for recent seismic events; research nearby construction activity.
• Acquire the geotechnical report, construction documents, a record of any previous repairs or of recent structural alterations, and interview building personnel.

PERFORM A LEAK SURVEY AND RECORD OBSERVATIONS OF CONDITIONS
• Prepare a drawing of the premises and chart all active leak sites and passive leaks sites that have been repaired.

CAUSE DETERMINATION
Leaking through concrete foundation walls and slabs on ground usually exhibits itself at cracks, cold joints, expansion joints, and penetrations. It is generally caused by either a failure of a structural element or components of the waterproofing system, often coupled with an unanticipated increase in hydrostatic pressure (Photo 1).

Structural failure may exhibit itself as cracks or opening of construction joints occurring from overloading, settlement, vibration, seismic events, creep, shrinkage, vehicular surcharges, or adjacent construction activities.

Leaking in below-grade walls and slabs is often caused by an unanticipated increase in hydrostatic pressure. It can be due to an intermittent rise in the water table or from a surcharge of water in the soil surrounding the foundation. Surcharges may be caused by record rainfalls, leaking sewers, or runoff from newly regarded areas.

Leaking through plazas is often caused by post waterproofing sprinkler and lighting installations (particularly in planters), failed drain flashing, ruptured expansion joint covers, cold joints in split slab construction, and base flashing terminations.

The source of an increase in hydrostatic pressure can often be identified by observing the color or odor of the infiltrating water or by chemical tests. (Photo 2)

REMEDIATION MATERIALS
Crystalline, hydraulic, and oxidized metallic cements and other cementitious materials penetrate concrete pores and react with moisture to expand and seal active leaks. Cementitious coatings are vapor-permeable and unsuitable for humidity-sensitive spaces.

Sodium bentonite is a hydrated, clay-based grout injected into the soil around foundations or injected through foundations and slabs. When injected into confined spaces, it forms a watertight curtain, provided the surrounding soil is moist. High pumping pressures can displace un-reinforced concrete or lightly reinforced masonry walls.

Epoxy is the preferred material for repairing cracks in structural components. They can also be used to stop leaks, but are not as effective as the chemical gels. They...
adhere well, but are relatively inflexible, do not tolerate movement, and are unsuitable for high-volume leaks.

Chemical gels and foams, such as urethanes, acrylate polymers, and similar hydrophobic and hydrophilic chemicals, injected into cracks and joints, expand on exposure to water and form a flexible gasket to stop leaks. They also expand in contact with water when injected behind foundations and under slabs to form water-impenetrable gel curtains.

The most common urethanes are hydrophobic gel for filling cracks and joints and hydrophilic foam for filling voids in the soil behind concrete foundations and slabs.

An acrylate polymer is a chemical gel that is similar to urethanes that expands upon contact with water. It has excellent adhesion and is effective in thin cracks and joints as well as behind foundations and under slabs. It forms superior flexible grout curtains that are unaffected by moisture, which compensates for its higher cost.

**REMEDIATION METHODS**

The location and severity of the leaks will generally determine the most appropriate remediation method. Often, more than one will be required. Critical factors for selection are: access to the foundation and slab from the interior or exterior, the degree of disruption to the occupants, and budget constraints. As a rule, it is best to begin with the easiest and least expensive method and graduate to more complicated and costly remedies. These include:

1. Reducing hydrostatic pressure by altering one or more of the following above-grade building components and topographical features.  
   - Installing roof gutters where they are absent.
   - Providing additional downspouts or increasing their size or decreasing their spacing.
   - Connecting downspouts to a stormwater sewer or extending them to daylight away from the building.
   - Ensuring positive drainage away from the building by re-grading or retaining walls.
   - Diverting surface water by swales or intercepting drains.

2. Using drains and pumps within basements at the perimeter or under slabs to remove infiltrating water (Figure 1).

3. Repairing or replacing positive-side waterproofing on plazas and foundation walls.

4. Applying crystalline, hydraulic, or cementitious/metallic coatings or fillers to interior surfaces or as a grout to fill joints, cracks, and holes.

5. Injecting bentonite grout in the soil surrounding the foundation wall (Photo 3).

6. Injecting epoxy in structurally unsound cracks and joints.

7. Injecting chemical grouts in the soil behind the foundations and under slabs.

8. Injecting chemical grouts into joints, cracks, and holes in foundations and slabs (Photo 4).
CONCLUSION
Basements leak because of failure or absence of a positive side waterproofing system, movements that open cracks and joints and unanticipated hydrostatic pressure. The protocol for remediating these leaks involves investigating their history and phenomena that may have changed the environment; the source of water that caused the pressure increase; and selection of the most appropriate methods for remediation. These include controlling water flowing from roof drainage systems, modifications to site topography, re-waterproofing, installing interior perimeter drains, injecting grouts into the soil surrounding foundations, and injecting chemical gels behind walls, under slabs, and in cracks and joints.

KEY WORDS
Leaks, Investigation, Remediation, Chemical Injection

REFERENCES
ACI 224.1R-93 Causes, Evaluation and Repair of Cracks in Concrete Structures, American Concrete Institute, Detroit, MI, 1998.
ALS Home Improvement Center, Waterproofing Basements.
Haisley, Phil, “Pushing the Building Envelope...Below Grade,” Interface, October 2001.
Polygem, Inc., Waterproofing Crack Injection Techniques.