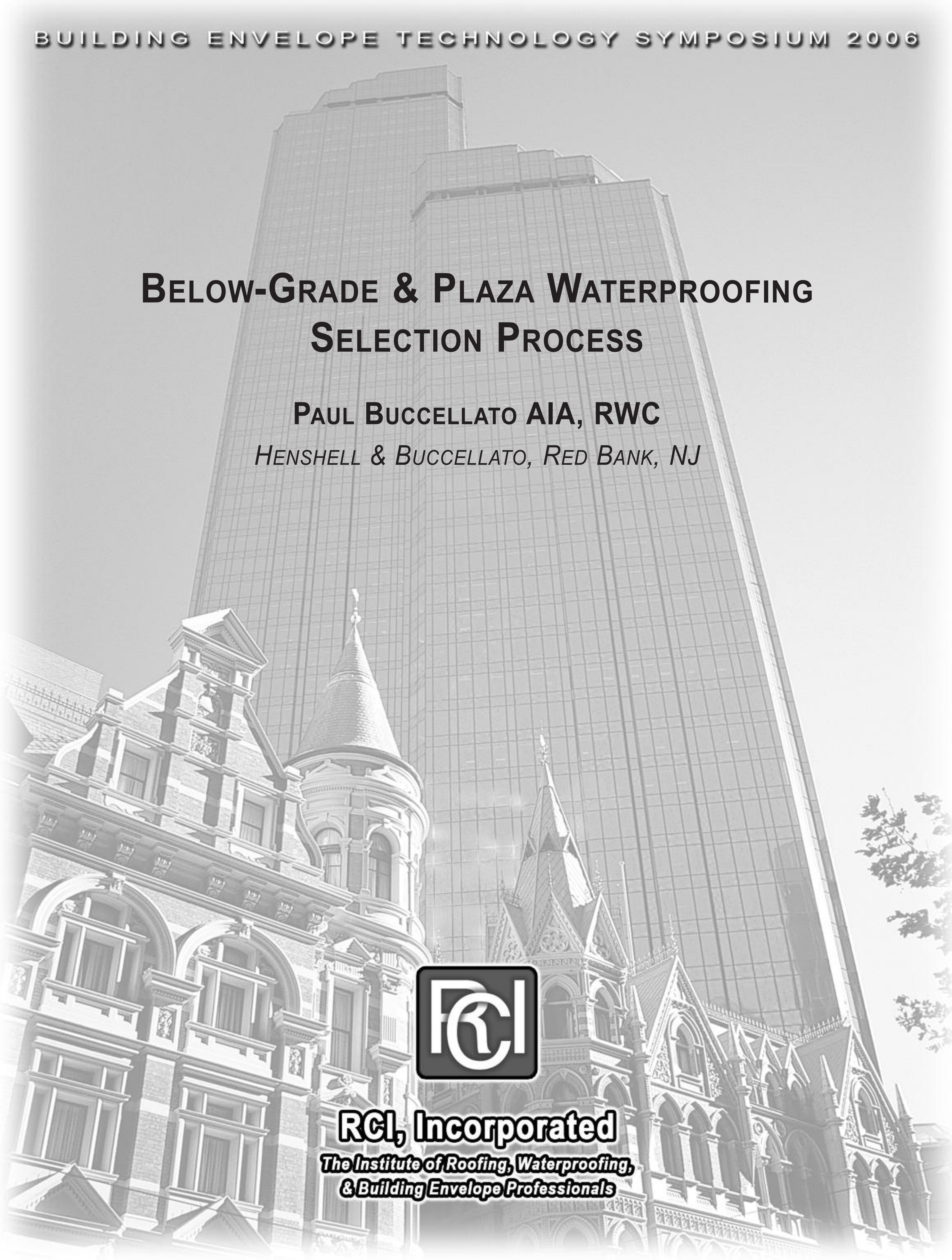

BELOW-GRADE & PLAZA WATERPROOFING SELECTION PROCESS

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The Institute of Roofing, Waterproofing, & Building Envelope Professionals

ABSTRACT

Waterproofing manufacturers are providing the industry with a growing supply of materials and systems, and designers are confronted with this bewildering range of choices. Selecting a waterproofing system should be based on performance. Since a waterproofing membrane must maintain its watertight integrity, the process should evaluate the conditions and performance criteria for the selection of the most appropriate system. Therefore, the designer should review each waterproofed building component on an item-by-item basis.

This paper will discuss minimum levels of performance for waterproofing membranes, code requirements, occupancy, hydrostatic pressure, soil characteristics, and construction sequencing. It will also include a discussion of system track records and cost-risk factors.

SPEAKER

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Mr. Buccellato is a registered architect in four states and holds a certificate from the National Council of Architectural Registration Boards. He is also a Registered Waterproofing Consultant with RCI. Buccellato is a member of the American Institute of Architects, the New Jersey Society of Architects, the Construction Specifications Institute, RCI, and ASTM, Committees D-08 Roofing & Waterproofing (chairman Subcommittee D08.20 Roofing Membrane Systems), C 15 Masonry Units, and C-24.

Mr. Buccellato has authored several technical papers on waterproofing and roofing, three ASTM standards on roofing, and has lectured at Brookdale College, NJ. He wrote a column on roof design for *The Roofing Specifier* and is co-author of an NCARB monograph on Built-up Roofing. He has presented papers relating to waterproofing and roofing for RCI and ASTM.

Mr. Buccellato is a member of the RCI Education Committee and NRCA's Educational Resource Committee. He is also a member of RCI's Waterproofing Examination Committee.

Below-Grade & Plaza Waterproofing Selection Process

INTRODUCTION

There is a general view in the industry that waterproofing[1] and roofing are somehow equal, interchangeable, and similar. As any design professional knows, this is far from the fact. True, the primary functions of the two are the same – to prevent water infiltration; however, waterproofing and roofing present the design professional with different problems.

Of the two, waterproofing poses the more difficult challenge. First, the roofing industry's history of low-sloped roof failures educated us to recognize the limitations of various roof systems. Although no one takes pleasure with a failed roof system, the cost of removing it is traditionally far less than the removal of a failed below-grade waterproofing system (*Photo 1*).

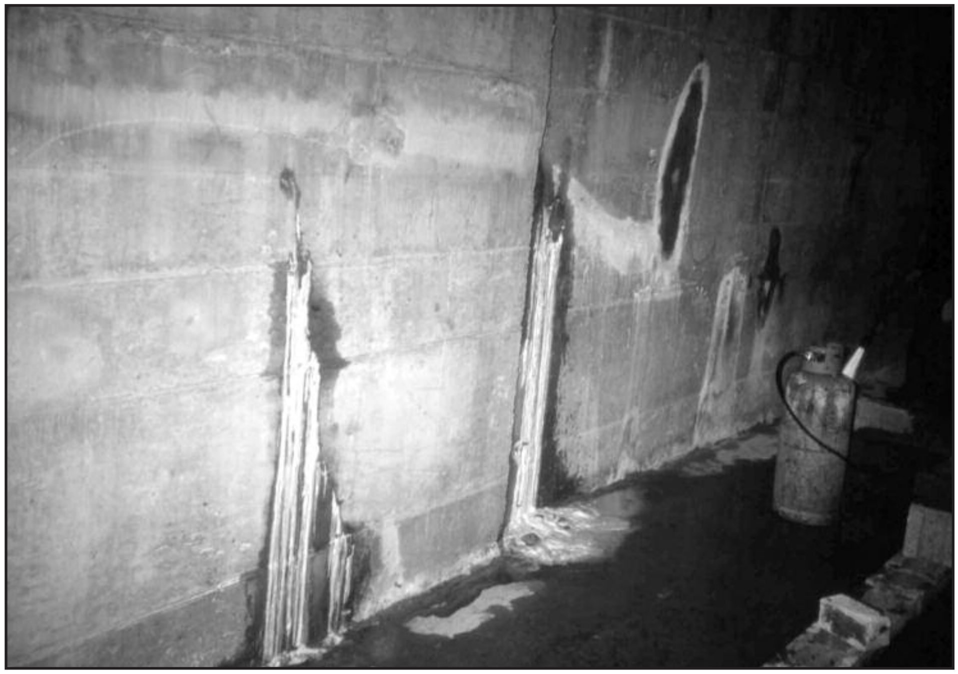

Photo 1 – Below-grade leak.

Improved guidance from roof membrane manufacturers was also a by-product of these failures. Additionally, various industry and professional organizations or associations provide information regarding the design of various roof systems. These include RCI, NRCA, ASTM, and others. Currently, the waterproofing industry is making strides to provide these services; however there is not a parallel effort on the same level with the roofing industry. One reason the waterproofing industry lags behind the roofing industry in this respect is its lack of litigation history.

The second reason that waterproofing is more difficult is the growing palette of materials and systems that have been introduced over the last 30 years. Since the appearance of liquid-applied membranes in the 1960s, modified bitumens; synthetic rubber and plastic sheets; polyester, liquid-applied formulations; laminated bentonite sheets; and others have been developed. These systems augmented the traditional built-up bituminous membranes, bentonite panels, and cementitious coatings. With the introduction of these new systems, the designer is now faced with a bewildering range of choices. Selecting an inappropriate waterproofing system can result in severe leaking and catastrophic financial losses. As design professionals, we should resist any and all temptations to merely select a system on the basis of past experience. Any cost-cutting measure that adds a slight increase in risk is not worth considering for a below-grade waterproofing project.

There are four basic types of waterproofing systems:

- Positive-side,
- Blind-side,
- Negative-side, and
- Integral.

Positive-side waterproofing is the most common type of waterproofing for new buildings and is applied to the outside or wet face of the substrate (*Figure 1*).

Blindside waterproofing systems are used where the exterior faces of foundation walls are inaccessible, requiring the waterproofing be applied to the formwork surface (*Figure 2*).

Negative-side waterproofing is the more appropriate choice for remedial waterproofing projects because of its ease of application to the inside or dry face of the below-grade substrate (*Figure 3*).

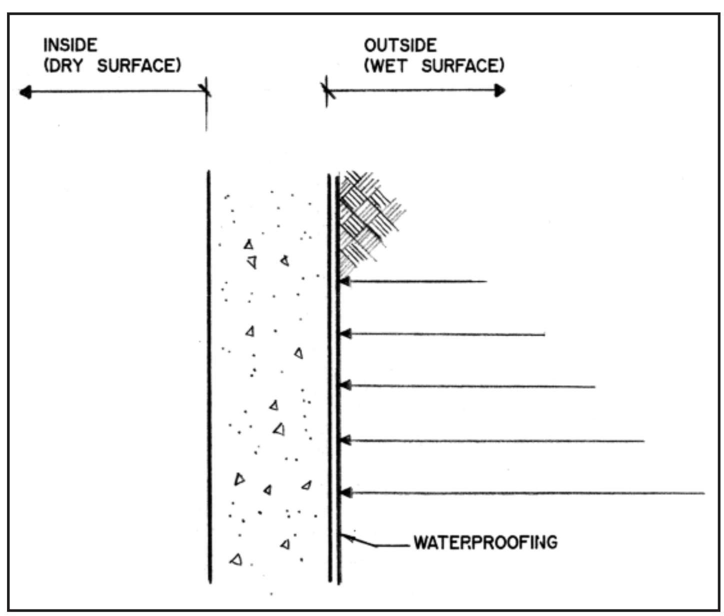

Figure 1 – Positive-side waterproofing.

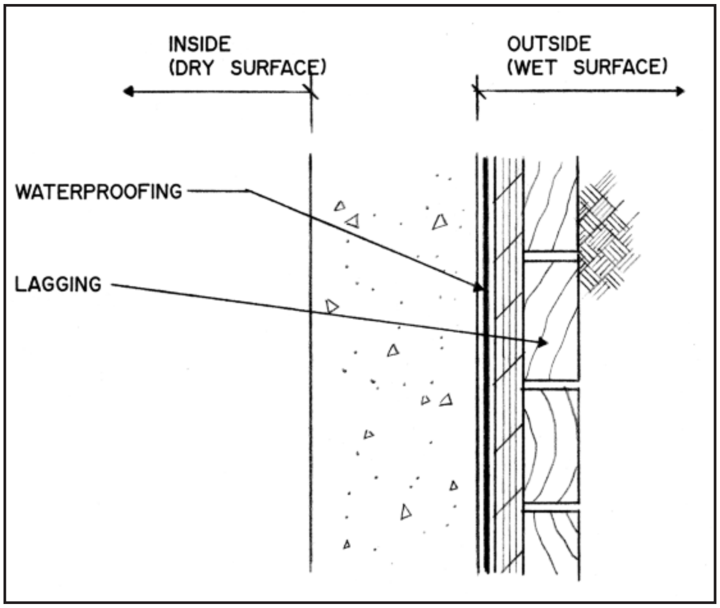

Figure 2 – Blind-side waterproofing.

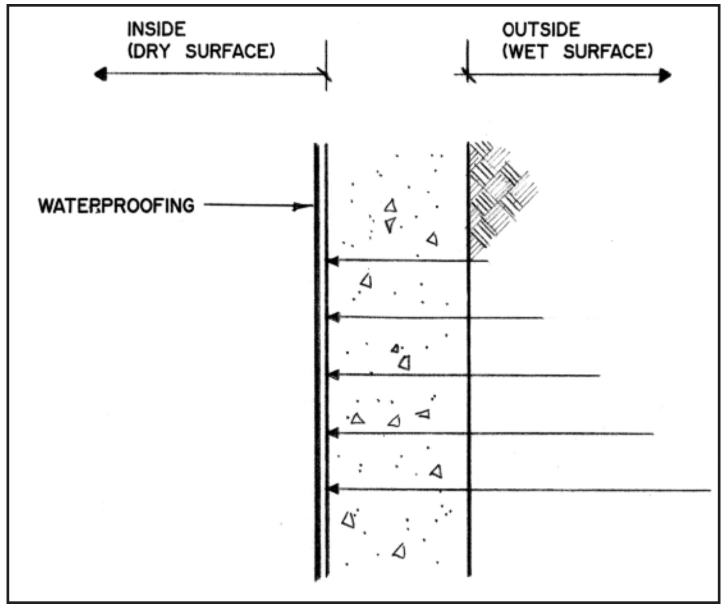

Figure 3 – Negative-side waterproofing.

Integral waterproofing consists of superplasticizers or other additives to improve the concrete's workability. These additives reduce porosity and increase the density of the concrete

The protocol for selecting a waterproofing system should proceed in an organized manner. The designer should always start by preparing a checklist for each building component that is to be waterproofed. Each item should be reviewed and a level of importance assigned. The sometimes effortless application of negative-side waterproofing may be immediately eliminated if there are chemically corrosive soils at the site. Anti-pollution regulations can eliminate membrane selection from the start, such as hot kettles that are required for built-up membranes. At the conclusion of this procedure, the selection of an appropriate waterproofing system becomes a summary of assets and liabilities. However, at our present state of knowledge, we cannot allow this process to be purely mechanical. We must always remember that there are numerous factors that make a project unique and therefore must be explored.

The list should outline the conditions affecting each component as follows:

1. Codes.
2. Groundwater conditions.
3. Soil conditions.
4. Occupancy parameters.
5. Structural requirements.
6. Construction procedures and sequences.
7. Product reliability.
8. Past product performance.

CODES

Code requirements set mandatory parameters. The 2003 International Building Code (IBC) contains the following provisions:

> **1807.2** Where hydrostatic pressure will not occur… floors and walls for other than wood foundation systems shall be dampproofed[2] in accordance with this section. [See *Figure 4*.]
>
> **1807.3** Where the groundwater table investigation… indicates that a hydrostatic pressure condition exist[s], and the design does not include a groundwater control system, …walls and floors shall be waterproofed in accordance with this section.

The code also contains the following:

> **1807.3.1** Waterproofing shall be accomplished by placing a membrane of rubberized asphalt, butyl rubber, or not less than 6-mil polyvinyl chloride or other approved materials under the slab.
>
> **1807.3.2** …Waterproofing [of walls] shall consist of two-ply, hot-mopped felts, not less than 6-mil polyvinyl chloride, 40-mil polymer-modified asphalt, 6-mil polyethylene, or other

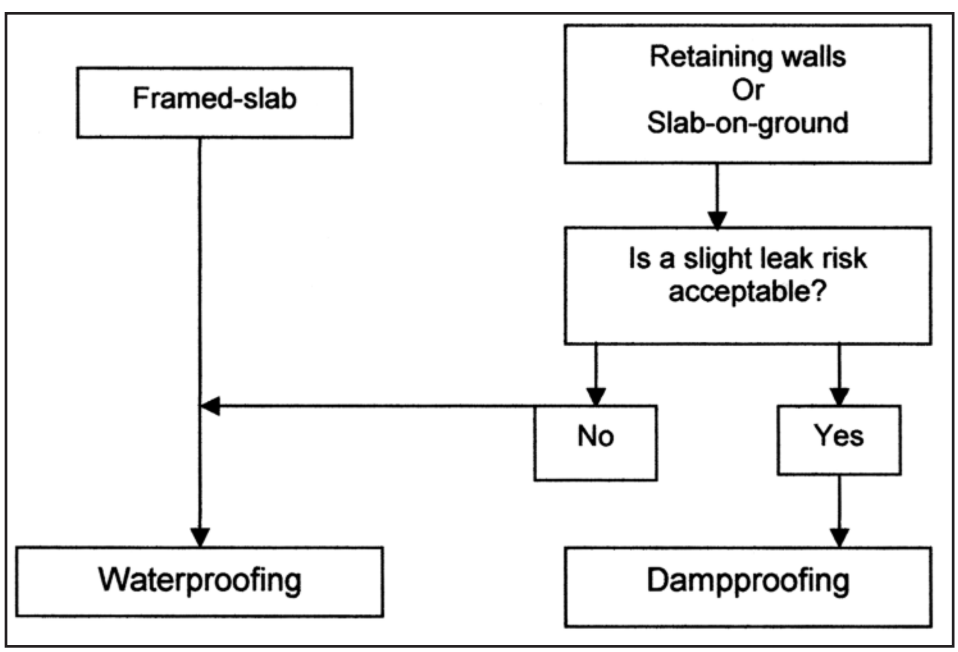

Figure 4 – A simplified chart for deciding on waterproofing vs. dampproofing.

Figures 5A (right) and 5B (below) – Geotechnical survey.

GEOTECHNICAL ENGINEERING STUDY

TEACHER'S COLLEGE
STUDENT RESIDENCE BUILDING
517 West 121st Street
New York, New York

Prepared For:

Mitchell Giurgola Architects
170 West 97th Street
New York, New York 10025-6492

Prepared By:

Langan Engineering & Environmental Services, P.C.
90 West Street, Suite 1210
New York, NY 10006-1039

INTEGRATED ANALYTICAL LABORATORIES, LLC.

SUMMARY REPORT

Client: Langan Engineering & Environmental, Inc.
Project: NYU - LOEB CENTER - 154601
Lab Case No.: 10990-3380

Lab ID:	3380-001
Client ID:	001 L2
Matrix:	Aqueous
Sampled Date:	6/15/99
PARAMETER(Units)	
Metals (ppm)	
Cadmium	ND
Copper	ND
Lead	ND
Mercury	ND
Nickel	ND
Zinc	ND
General Analytical	
Total Petroleum Hydrocarbons (ppm)	0.42
Flashpoint (°F)	>140
Corrosivity as pH (S.U.)	6.67
Total Suspended Solids (ppm)	82
Oil & Grease (ppm)	1.1
Chromium, Hexavalent (ppm)	ND
Cyanide, Amenable (ppm)	ND

ND = Analyzed for but Not Detected at the MDL
> = Greater than

approved methods or materials capable of bridging cracks.

As stated in IBC Sections 1807.3.1 and 1807.3.2, these clauses effectively rule out bentonite, negative-side waterproofing/ coatings, and conventional, built-up membranes. The phrase, "other approved materials" does preclude the designer to seek the code officials' approval for materials outside the stated scope.

Closely linked to code requirements are VOC (volatile organic content) regulations. These rules can effectively eliminate some waterproofing systems that require solvent-based adhesives and primers. These regulations require early investigation by the designer to avoid unnecessary complications.

GROUNDWATER CONDITIONS

The evaluation of the groundwater[3] conditions begins with the geotech report based on soil borings prepared by a geotechnical engineer (*Figure 5*). The information acquired from the borings should be reviewed and adjusted for seasonal variations. Water tables are generally higher in the northern hemisphere after the spring thaws have saturated the ground and lower after the summer evaporation of surface moisture.

Borings taken in July, August, or December may not provide the designer with an accurate interpretation of the site's most severe water table elevation, and therefore should be adjusted.

Soil borings and test pits determine:

- Water table elevation and the presence of underground streams, tidal, and perched watertables.
- Deleterious soil chemicals, saltwater, petroleum derivates.
- Other hazardous conditions and soil stability.

The presence of hydrostatic pressure[4] is fundamental when selecting a waterproofing system. Its force, duration, and nature must be considered during the selection process – as well as whether it is continuous or intermittent or if it is flowing or static.

The installation of underslab drains and footing drains (*Figure 6*) can drain water below the slab when the groundwater level is lower than 12 inches below the slab. Waterproofing can then be applied to walls for rainwater seepage.

Membranes of low absorption perform well when hydrostatic pressure is continuous. If the membrane has high absorption characteristics, it can swell (*Photo 2*), disbond from its substrate, or wrinkle. Membranes that become wrinkled are subject to increased risk of puncture or rupture and seam disbonding.

The application of negative-side waterproofing[5] to inside subsurface space offers interior resistance to hydrostatic pressure, but lacks the ability to protect the substrate – typically concrete – against corrosive soils. Epoxy coatings can protect re-bars, but positive-side waterproofing protects concrete from corrosive soils.

SOIL CONDITIONS

Soil characteristics include chemical and physical properties that may affect waterproofing membranes. When a negative-side waterproofing system is selected, it can leave the exterior side of a foundation wall unprotected. Soils that have high pH levels can accelerate deterioration of the

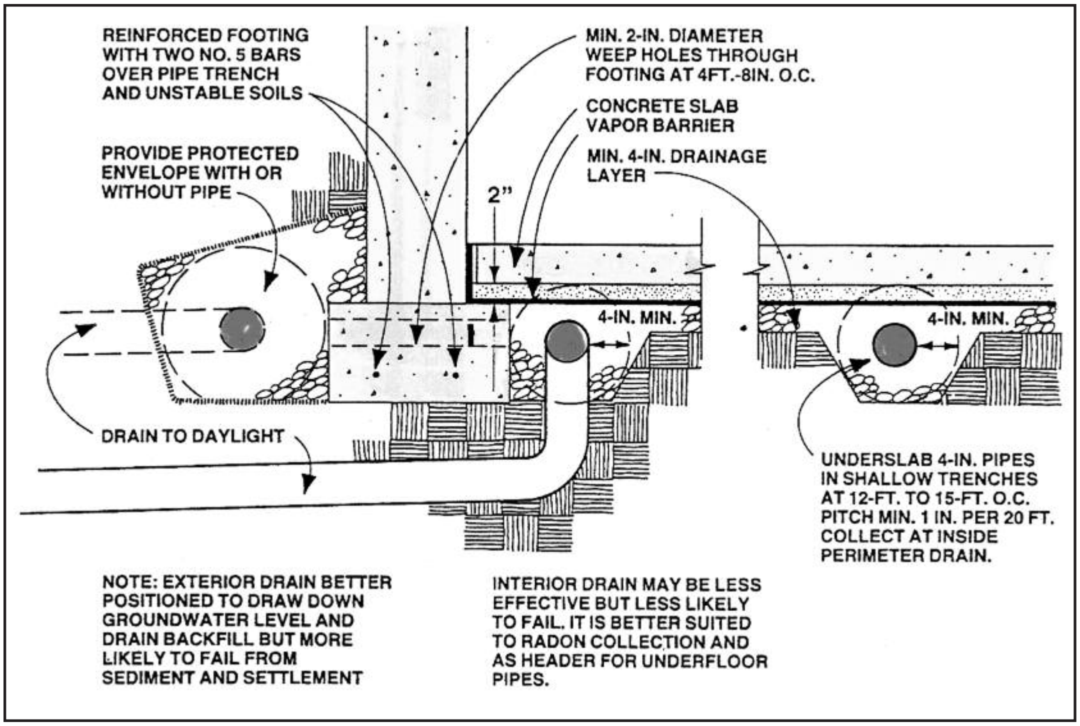

Figure 6 – Underslab/footing drainage.

concrete, including the steel reinforcing bars. Acids, alkalis, saltwater, salts, sulfates, calcium hydroxides, pesticides, and petroleum products that may be in the groundwater are highly corrosive contaminants that can cause extensive damage to the structural foundation and slabs.

The design professional should also be concerned about the physical soil conditions. Clay soils usually limit underground hydrostatic pressure, whereas granular or sandy soils maximize hydrostatic pressure.

OCCUPANCY PARAMETERS

The type of intended occupancy of any below-grade space is a critical factor in the selection of the waterproofing system. Two factors that can limit the range of membrane system choices for below-grade spaces are:

- The area has a zero leak-risk tolerance, and
- It is humidity-sensitive.

High-risk occupancies include book storage areas, audio-visual rooms, computer rooms, electrical switchgear, and medical facilities. A leak into one of these spaces can be catastrophic.

A designer should eliminate negative-side waterproofing from below-grade spaces that have occupancies with a low tolerance for high humidity, such as audio-visual equipment or art storage. Positive-side waterproofing systems[6] with a low vapor permeance rating are more appropriate for these occupancies.

STRUCTURAL REQUIREMENTS

A review of the structural system or substrate, which includes the foundation and slabs, should be performed prior to selecting a waterproofing system. If hydrostatic pressure is not present and the primary concern is protection against corrosion, then dampproofing will provide adequate protection.

Expansive soils may cause footings to rise or settle that may crack footings or the foundation walls above the footings. In these instances, the membrane selected must have both elastic and self-sealing properties.

CONSTRUCTION PROCEDURES

Local construction methods and sequencing operations require close attention by the design professional. Earth retention systems (*Photo 3*) and methods of site dewatering (*Photo 4*) can influence the waterproofing system. Long construction delays may also influence the selection of the waterproofing system.

The waterproofing system selected must be capable of resisting freezing temperatures if it is applied and left exposed during cold weather. The majority of waterproofing membranes have low resistance to UV radiation and can deteriorate when exposed to sunlight for intervals as short as a month.

Construction sequencing can put a waterproofing membrane under unexpected stress. A multi-level basement with foundation walls may rely on intermediate slabs or shear walls for lateral support. If the foundation is waterproofed before these secondary structural elements are cast, the foundation wall may deflect, with devastating consequences for the membrane. Also,

Photo 2 – Swelling of liquid-applied membrane.

Photo 3 – Earth retention system.

dewatering systems cannot be discontinued if the weight of the superstructure is used to offset the hydrostatic pressure.

PRODUCT RELIABILITY

The designer should review, in detail, the track record for each system being considered for a project. This review should include the manufacturer's reputation and warranty provisions. When reviewing the system's history, the designer should ask:

- Is the product manufactured by the seller or is the seller a distributor?
- What is the manufacturer's track record?
- What is the system's history, including successful performance under comparable conditions being anticipated for the current project for at least 15-20 years?
- Has the membrane manufacturer maintained a consistent formulation of the product for a minimum of ten years?
- What are the terms of the warranty? Is it limited to materials only? Does it include workmanship? What about removal of overburden?

The warranty should not be a major consideration, since the majority of waterproofing membrane manufacturers warrant their products for between three months and five years. A few will warrant for as long as ten years. Moreover, most warranties cover only materials that are proven to be defective. The cost of removing overburden, pumping water, and the cost of remediation when the waterproofing is inaccessible, are not considered to be liabilities to the membrane manufacturer. These costs can be many times the cost of the waterproofing repair or replacement. So don't rely on manufacturers' warranties to keep the building dry.

PRODUCT PERFORMANCE

Buildings are designed to last at least 80 years. Roofs can last for 20 - 25 years, but waterproofing must perform for the life of the building.

Therefore, when considering a waterproofing membrane, the designer should evaluate the product's performance regarding anticipated conditions that may be expected, such as:

- Does the durability of the product match anticipated conditions?
- Does the membrane stability match the predicted life of the building?
- What is its capability to withstand movement and cracking in the substrate?
- Is the membrane repairable in the event of localized leaking?

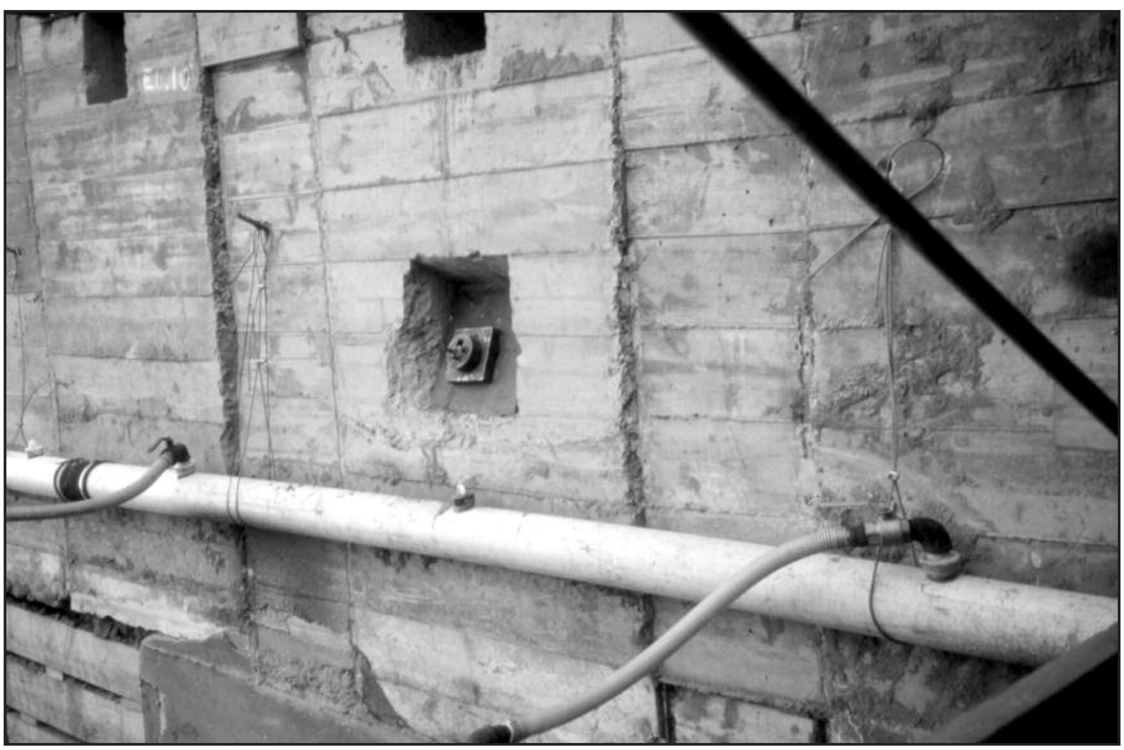

Photo 4 – Site dewatering system.

Ease of material application and local practices may also be included under product performance. Although these can be relatively minor factors, their consideration can result in better performance and workmanship. When, during the review process, it is determined that all factors are more or less balanced, the ease of applying the material could be the final decision in the selection of a waterproofing membrane or system.

CONCULSION

The design professional should minimize the risk of leaks and failure when selecting a waterproofing membrane for a project. The failure of a waterproofing system may occur without leakage of liquid moisture into the building. Spaces that are environmentally sensitive are frequently being located underground. The waterproofing of these spaces requires greater dependability and durability than the waterproofing of sidewalk vaults over a building's utility space.

When value engineering is required to control construction cost, the waterproofing system should be the last place to look for economy.

No designer can specify a failure-proof system. Therefore, he should review and evaluate the waterproofing system on the conservative side.

KEYWORDS

Waterproofing, Positive-side, Blindside, Negative-side, Integral, Failure

BIBLIOGRAPHY

ACI Guide 515, 1R79 *Guide to the Use of Waterproofing, Dampproofing, Protective and Decorative Barrier Systems for Concrete*, ACI, Detroit, MI Revised 1984.

Anderson, Brent, *Underground Waterproofing*, 1982.

Kubal, Michael K., *Waterproofing the Building Envelope*, McGraw-Hill, Inc. New York, NY.

National Roofing Contractors Association, *The NRCA Roofing & Waterproofing Manual*, Fifth Edition, 2001, Rosemont, IL.

Henshell, Justin, *The Manual of Below-Grade Waterproofing Systems*, 2000, John Wiley & Sons, Inc., New York, NY.

REFERENCES

1. Waterproofing is the treatment of a surface or structure to prevent the passage of water under hydrostatic pressure.
2. The treatment of a surface or structure to resist the passage of water vapor and water in the absence of hydrostatic pressure.
3. The elevation in the soil where water is at atmospheric pressure.
4. Pressure exerted by stationary liquid water, in all directions, against adjacent surfaces.
5. A waterproofing system in which the source of the hydrostatic pressure and the water-resisting element are on opposite sides of the structural component.
6. A waterproofing system in which the water-resisting element and the source of the hydrostatic pressure are on the same side of the structural component.