INSIGHT

ISSUE NO. 1

A technical newsletter by Raths, Raths & Johnson, Inc. for the construction industry.

"Insight: to see into and understand; an item of knowledge gained by this power."

That is what we will bring to our readers. In this premier issue of *RRJ Insight*, you'll find just a sampling of valuable information which will be coming to you as a regular newsletter. Look for useful Project Profiles, Technical Tips, Laboratory News and current trends from the experts in structural and architectural engineering.

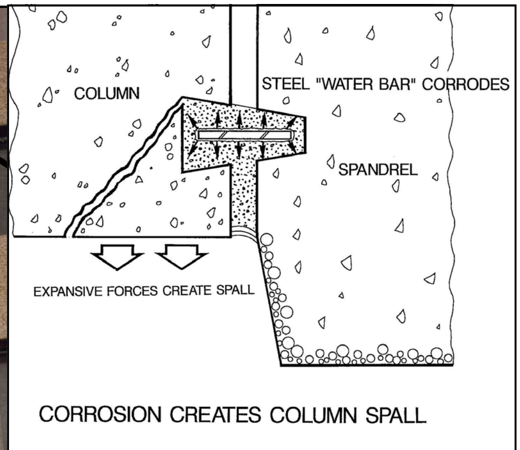
INSIDE

See the article under **Project Profile** on the next page.

Project Profile

Lake Front High-Rise Rehabilitation

Spalling adjacent to spandrel panels caused by corrosion of concealed steel "water bar."



Carmen Marine Apartments, a 26-year old low income high-rise residential tower located adjacent to Lake Michigan on Chicago's north side, has experienced a long history of building problems. The history of non-performance is not unlike many other high-rise residential buildings constructed during the 60's and 70's. The residents have endured a building envelope that has allowed uncontrolled water infiltration to enter the interior and damage the exposed and concealed building materials. Non-insulated walls and poor performance windows have caused excessive air infiltration and thermal discomfort. The exposed exterior concrete columns exhibit large areas of spalling due to corrosion of reinforcing steel. In addition, the attached parking garage exhibits serious structural problems requiring an aggressive repair approach. Earlier this year, through diligent efforts of a strong team of residents and advisors, the building was purchased by the Carmen-Marine Tenants Association and acquired the necessary funding to perform a complete rehabilitation of the building's interior and exterior as well as the parking garage. The project is unique in that Carmen-Marine Tenants Association has become the first resident council in the country to purchase a new a building under Title VI of the 1990 Housing Act. The purchase and rehabilitation will help to preserve the building as low income housing for the next 40 years.

Raths, Raths & Johnson, Inc. (RRJ) has provided structural and architectural engineering services as a prime consultant to the technical team that includes: the Project Architect, Landon Associates, the Owner's Project Representative, Chicago Community Development Corporation, and the mechanical/electrical engineering consultant, Calor Design Group. E. W. Corrigan Construction Company of Oak Brook, Illinois has been selected to be the General Contractor for the project.

RRJ's work scope for the building tower included performing engineering investigations and evaluations of the physical conditions of the exterior facade to determine the extent of remedial work required. Close-up examinations and material samples were obtained during inspections which were performed from swing stage platforms.

The major components of the facade included cast-in-place concrete columns, precast concrete, spandrel panels, and mulled aluminum windows. Testing was performed to determine the water infiltration paths and the water resistance of the spandrel panels.

RRJ found that the continual intrusion of water had severely degraded the concealed steel components and precast spandrel panel connections. One of the most detrimental effects of water infiltration was the corrosion of a concealed "water bar" which exists in a key way pocket between the columns and precast panels. The expansive forces resulting from corrosion caused large spalls to occur on the face of the exterior columns. The resulting spall provided a means for uncontrolled water entry.

RRJ studied repair options with the technical team and developed drawings and specification for corrective work to the building envelope deficiencies. The remedial work includes: removal of the concealed water bars and patching of the concrete; installing supplemental anchorage for the spandrel panels; replacement of the windows with high performance aluminum windows; sealant replacement; and insulating the exterior walls.

- Ken M. Lies, AIA

Tech Tip

Condensation in Walls

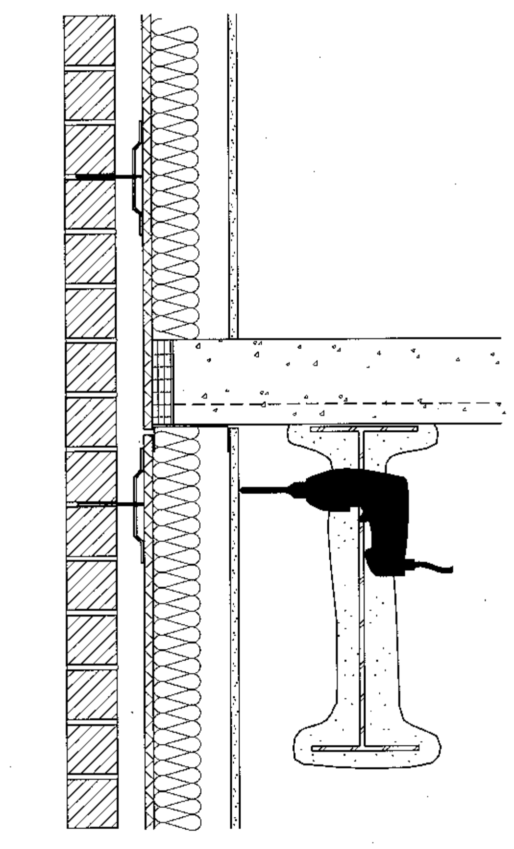
The condensation performance of wall assemblies is not always consistent with expectations. **Walls which should theoretically perform well have experienced condensation problems.** Calculations to determine the likelihood of condensation within a wall, such as the procedures in the ASHRAE Handbook of Fundamentals, assume a steady state model in which water vapor diffuses through wall materials. The vapor is propelled by partial vapor pressure differentials based on temperature, and the temperature of each wall layer is calculated assuming heat transfer by conduction. The model is accurate if the wall behaves the way the diffusion/conduction model assumes. Moisture transported along air paths can have a significant influence on behavior, but it is not accounted for in the model. Moisture can move along an air path even if there is no air velocity along the path.

Air paths which can cause condensation problems result from details which do not create closure to isolate interior humidified air from the cold regions within a wall. **There are often conflicting detailing require-ments** which must be addressed to prevent this problem. For example, it is good detailing practice to leave a gap between an infill masonry backup wall and the underside of a spandrel beam. If the gap is not sealed it provides an unobstructed path for interior moisture to reach the outer layers of the wall and condense. Satisfying the structural detailing requirement creates a potential condensation problem unless additional measures are taken. Another problem situation is suspended shelf angles which require diagonal kickers. The kickers must penetrate the interior skin of the wall, which is usually dry-wall. If the penetration is not sealed carefully, each kicker creates an air path to the outer layers of the wall where condensation can occur.

The size and location of spandrel beams often complicate closure details and construction procedures. The spandrel area must be considered in its entirely during the design phase. For example, the sketch shows a common stud wall detail in which it is impossible to properly install a sheet vapor retarder or to screw the interior drywall to the studs because of interference by the spandrel beam. The situation creates an open air path which has resulted in the need for **expensive building repairs.**

For additional information, see Kudder, R. J., Lies, K. M., Hoigard, K. R., “Construction Details Affecting Wall Condensation”, Symposium on Air Infiltration, Ventilation and Moisture Transfer, The Building Thermal Envelope Coordinating Council, December 2, 1986, Fort Worth. (Available from RRJ)

- Robert J. Kudder, S.E.



INTERFERENCE FOR INSTALLATION OF DRYWALL SCREWS AND TAPE

Laboratory News

Pressures Generated During Curtain Wall Hose Tests

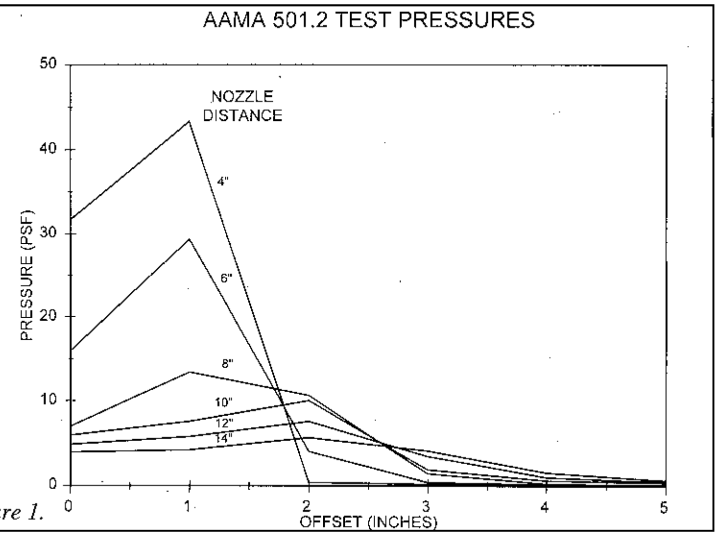


Figure 1.

Many project specifications written today include provisions for window and curtain wall leakage tests, the two most common types being the “chamber” and “hose” varieties. Chamber tests use a uniform water spray in conjunction with differential pressure to simulate wind-driven rain. Racks of calibrated nozzles, and sealed test chambers with centrifugal blowers are used to provide the water spray and a measurable pressure differential (frequently 6.24 psf). The methods of ASTM E 1105 or AAMA 501.3 are typically followed.

Hose tests, on the other hand, use much simpler equipment. The AAMA 501.2 test method **requires only a garden hose** with a calibrated nozzle and pressure gage. The procedure involves spraying 5 feet of window or curtain wall joinery for 5 minutes with the nozzle 12 inches away, and the hose pressure at 35 psi.

A frequently asked questions regarding hose testing is, **“How much pressure is applied to the tested area?”** The answer is not as clear as in the case of the chamber test with a known applied differential pressure. Fluid mechanics tells us that water impacting a surface at a velocity will produce a pressure due to the change in momentum (the water stops when it hits the window). Calculations to determine how much pressure is generated rely on many assumptions regarding flow and pattern characteristics of the nozzle being used, **RRJ conducted tests** with a manometer port and standard Monarch B-25 nozzle at perpendicular distances ranging from 4 to 14 inches, and lateral offset distances ranging from 0 to 9 inches (Figure 1). The size of the pressure port was also varied from 0.125 to 0.345 inches in diameter.

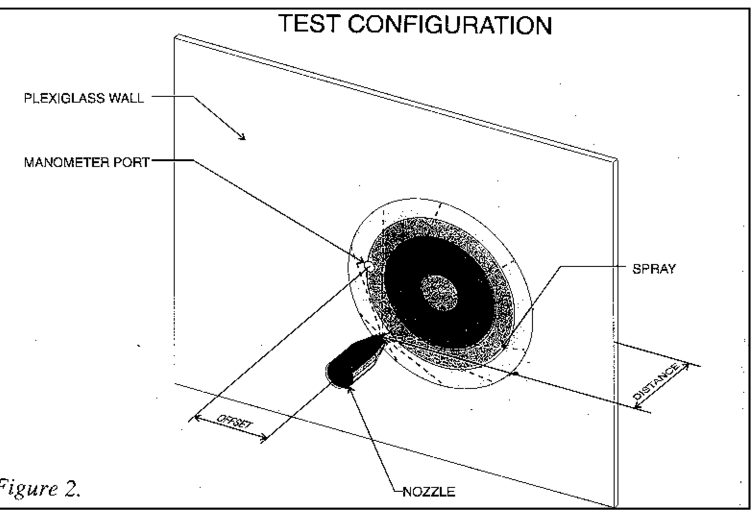


Figure 2.

A graph of the measured pressures is shown in Figure 2. Principle findings are:

- The nozzle spray pattern is not uniform. Maximum pressure occurs not at the center, but in a concentric ring around the center.
- The maximum pressure generated at the standard distance of 12 inches is approximately 7.6 psf. Substantially higher pressures are achieved as the nozzle is moved closer to the test specimen.

The work demonstrates that leakage testing of window and curtain wall components by the methods of AAMA 501.2 can generate significant pressures. These pressures, however, are only sustained over relatively small areas at any given time, and are applied only to the surface being sprayed.

– Kurt R. Hoigard, P.E.