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CONCRETE REPAIR BULLETIN

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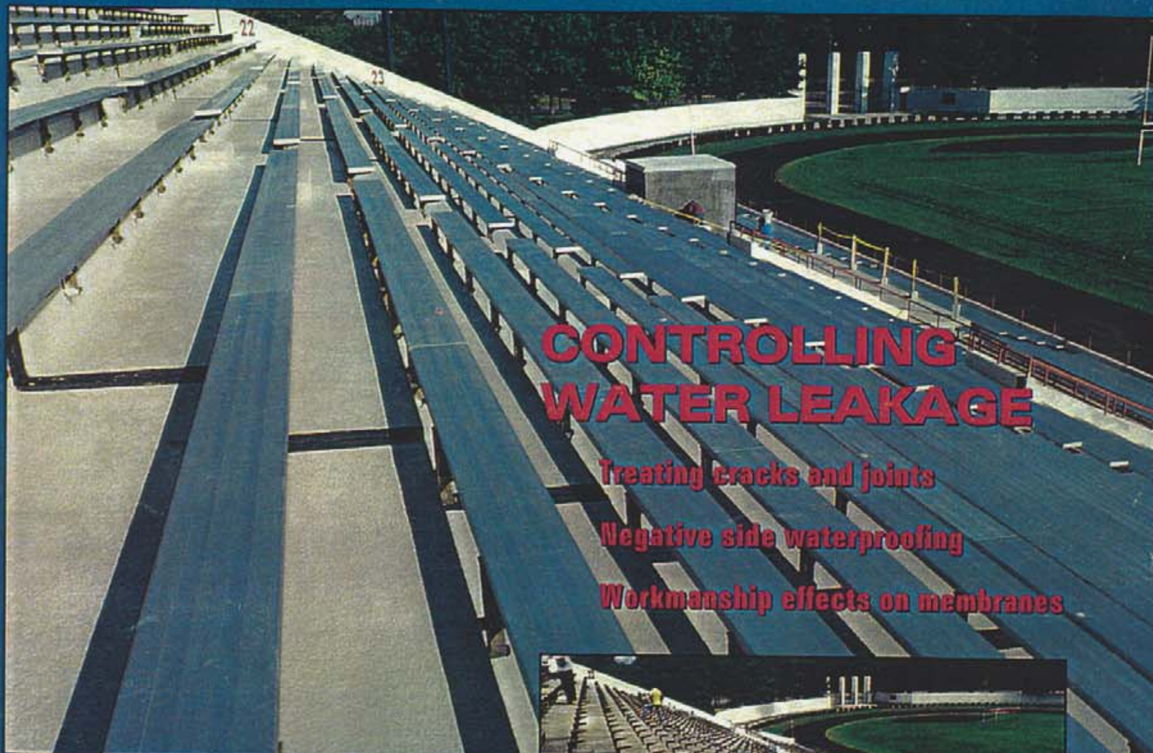

CONTROLLING WATER LEAKAGE

Treating cracks and joints

Negative side waterproofing

Workmanship effects on membranes

ICRI Annual Membership Meeting

January 20, 1997 • Las Vegas, Nevada

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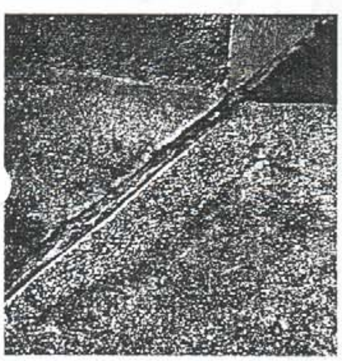
Joint replacement and MMA coating waterproofs White Stadium

Michael S. Teller, A.I.A.

Water continued to leak into the George Robert White Stadium in Boston, Massachusetts even though a limited renovation was done in 1989. New expansion joint sealant and a single coat of methyl-methacrylate (MMA) failed to keep the water out of the 5,000-seat, cast-in-place concrete grandstand. In May 1993, the owner initiated a thorough evaluation program to identify existing deficiencies and develop a repair strategy to keep the structure dry. Repair work began two years later and was completed in five months at a cost of $550, 000.



Photograph by CBI Consulting Inc.

Sources of leaks found

In the condition survey, defects were recorded on plans to locate damage trends. Expansion joints and caulking were removed to determine the mode of failure. Water testing and coring verified the primary sources of the leaks, which included failed expansion joints, failed joint sealants, cold joints, and cracks. Other moisture problems that led to the deterioration of the concrete were poor drainage, ponding, and condensation on the underside of the grandstand.

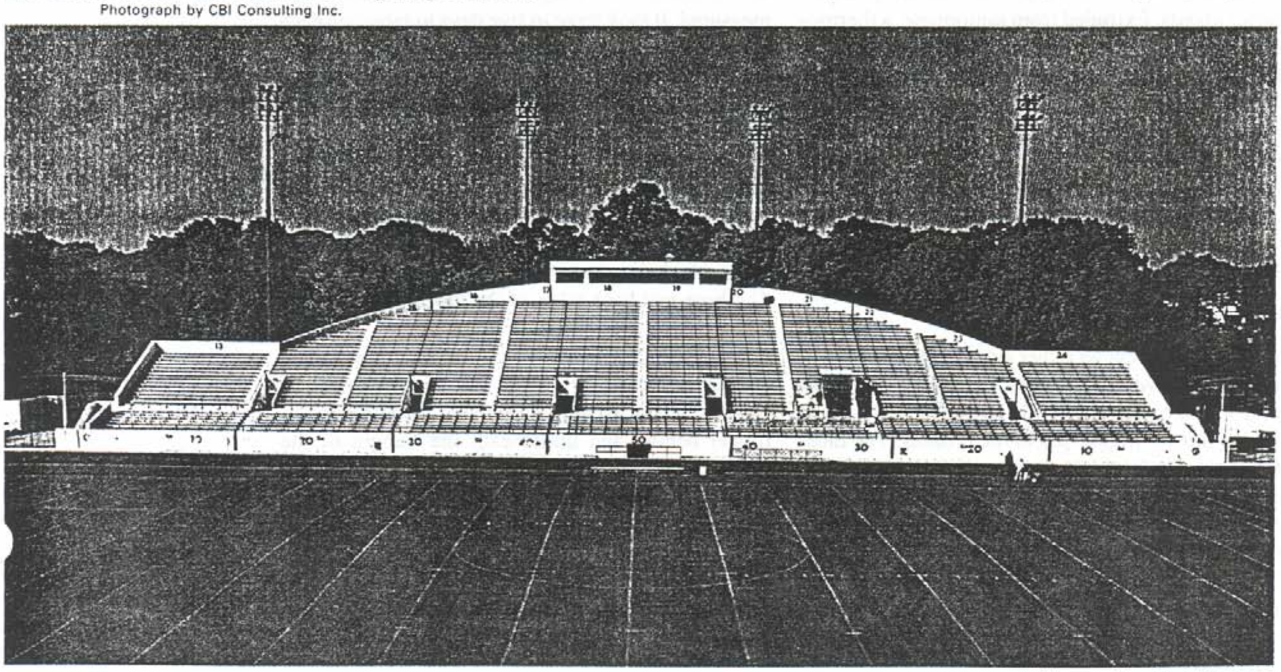
Left: Many of the existing expansion joints experienced cohesive failure of sealant.

Below: The six expansion joints run parallel up the grandstands.

Expansion joint selected

Various types of joint systems were evaluated. The most important selection criteria was the system's ability to maintain continuity through the transitions over the treads and risers. Other criteria included 3/4 inch (19 mm) total movement capacity, long-term durability, pedestrian suitability (flush finish, heel resistance), and coating compatibility. Two main types of expansion joint technology were examined: joint-face-adhered and blockout-mounted.

The joint-face-adhered type is an extruded neoprene seal bonded to the joint face using an epoxy adhesive (*figure 1*). In this system, successful anchorage is entirely dependent on the durability of the bond between the epoxy adhesive and the neoprene joint material. Transitions in the neoprene seal are glued together in the field using a cyanacrylate glue. The questionable feasibility and longevity of glued



Photograph by Abbott-Boyle, Inc.

Figure 1. Joint-face-adhered

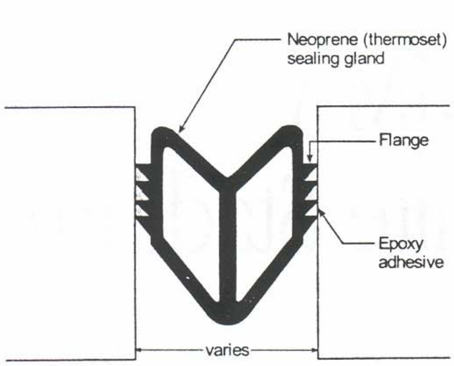
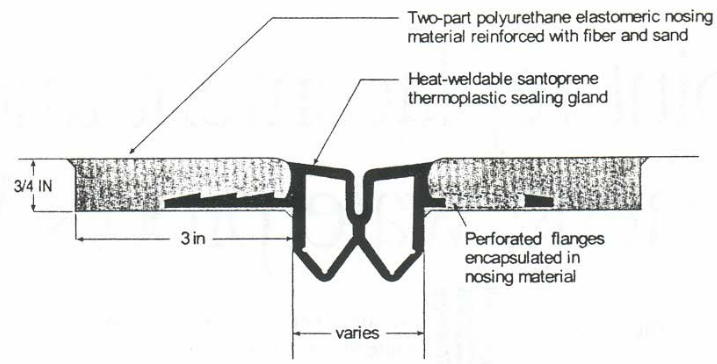


Figure 2. Double barrier gland, blockout mounted



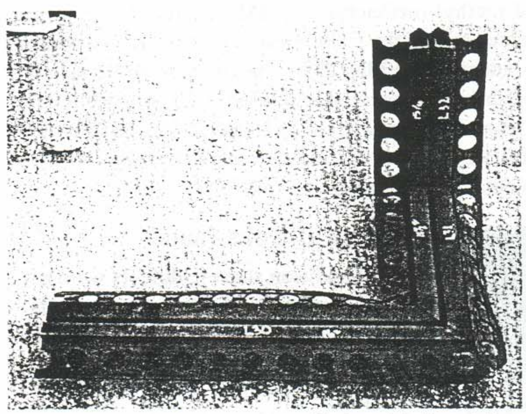
transitions, combined with the lack of mechanical anchoring, served to eliminate this joint type from consideration.

Blockout-mounted membrane nosing systems consist of an extruded rubber gland with flanges encapsulated in elastomeric concrete (*figure 2*). Three different types of membrane nosing system glands were considered: multicell, single-barrier, and double-barrier. Multi-barrier glands were more heavy-duty than required for the project and were eliminated based on size and expense. The transition in the multicelled glands would have been difficult to achieve either through welding or bending. Although the single-barrier gland could be easily bent around corners, it did not compare to the advantages offered by the double-barrier gland.

The double-barrier gland has two levels of water protection and 2½ inch (63 mm) movement capacity. This system also leaves a smooth pedestrian surface that is more resilient and stable than with single-barrier glands. Extruded from santoprene, a thermoplastic rubber, the double-barrier gland is heat-weldable, which allows the transitions in direction and plane to be factory-fabricated and then assembled in the field. Once welded, the transitions would retain 80% of the material's original strength and, unlike glued transitions, will not dry out or weaken with time. Each 90 degree transition consists of two welded 45 degree cuts so that the gland is not distorted by bending.

Expansion joints installed

Blockouts were cut on either side of the joint gap in horizontal and vertical surfaces. Cutting the blockouts in the inside corners where the treads meet the risers was the most difficult step in the process. The most effective tools for this task proved to be 4 inch (100 mm) diamond cutters and grinders. The blockouts required further grinding to remove irregularities. A jig was created to guide the grinder to the correct depth. Chamfers were ground on the edge of the joint gap to prevent damage to the sealing gland when the joint gap narrowed during thermally-induced increases in the volume of tread and riser elements.



Photograph by Emseal Corp.

***Above:** Joint-face-adhered joints were considered (figure 1), but blockout mounted joints were chosen (figure 2).*

***Left:** Factory supplied transition piece with horizontal mitre and vertical 90° turn.*

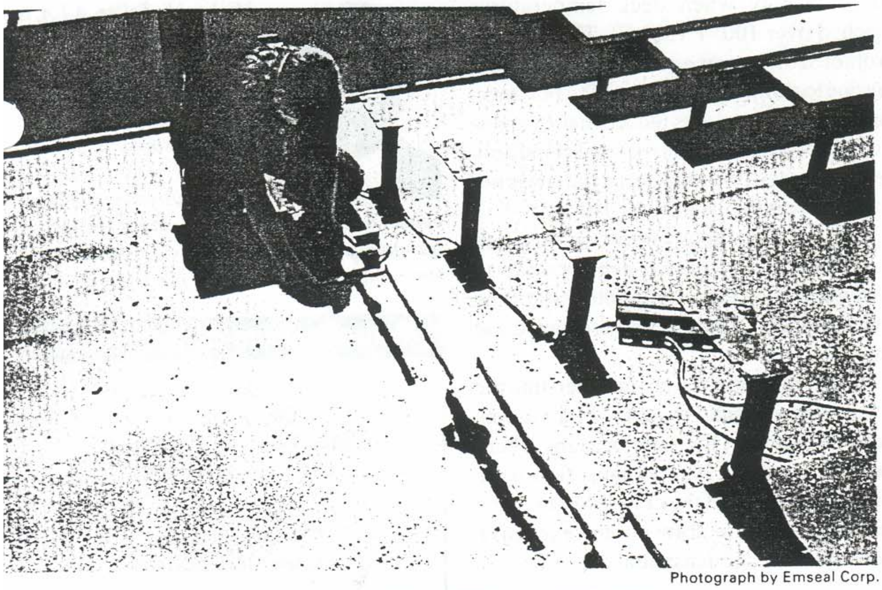
The most demanding aspect of the joint installation was the fabrication and installation of the 420 factory-welded tread and riser transitions. Once the blockouts were prepared, every segment of each joint was field-measured. It took three to five days to fabricate each of the six joints. As each joint segment was completed, the welds were water tested at the factory. The joints were labeled and shipped in sections consisting of ten treads and risers.

The blockouts were vacuumed and wiped to provide a dust and oil-free substrate for the nosing material. The sealing gland was inserted and seated firmly into the joint. The top of the gland and the edge of the blockouts were taped to keep the edges neat. The base and back edge of the blockout were then primed.

Placement of the cold-applied, two-component polyurethane nosing material was done in two stages. First, a non-sag version of the material was applied by trowel behind and underneath the flanges of the sealing gland to act as a setting bed. The non-sag material was tooled into a "stop," or dam, at the top of the risers to hold back the pourable nosing material.

Protective coating selected

The presence of fine cracks, the concrete surface profile, carbonation depth, and concrete spalling made



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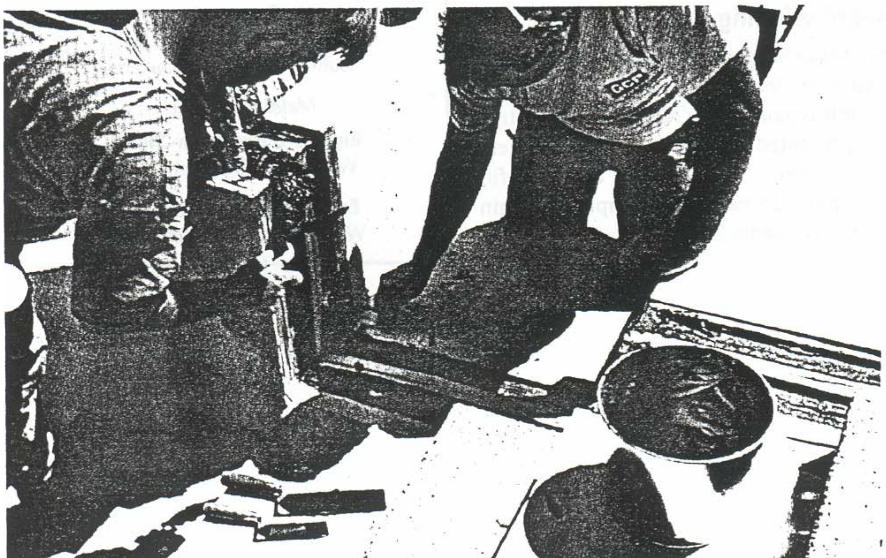
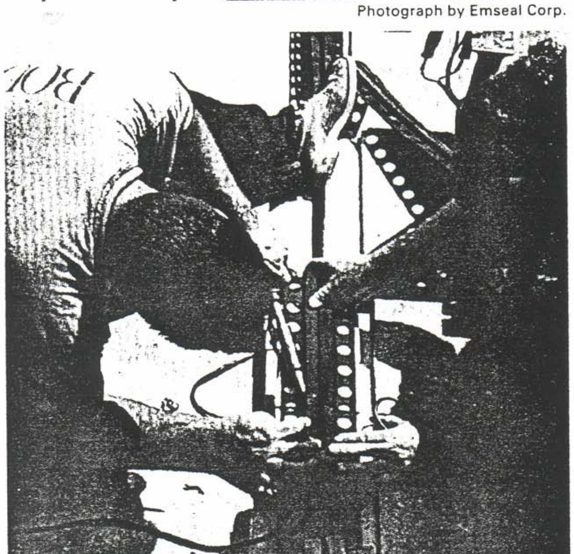


Photograph by Emseal Corp.

Top: A worker grinds the blockout by using a jig.

Above: Non-sag nosing material is trowled into the joints at the verticals.

Right: A heating tool is used to complete welds and make adjustments to the gland.



Photograph by CBI Consulting Inc.

a waterproofing coating an integral part of the repair strategy. The selection criteria for the protective system included compatibility with the existing MMA coating, effectiveness, durability, slip resistance, and appearance. The cost of removing the existing primer coat of MMA, which had penetrated the surface, was too high. Therefore, the waterproofing material selected would have to be compatible with the existing coating.

In the initial stages of coating selection, the cost and crack-bridging properties of cold-liquid-applied urethane systems seemed to provide an attractive alternative to the MMA coating. Test areas of urethane coatings of proprietary blends were applied and pull tests were performed to determine adhesion. The field evaluation revealed that adhesion of the urethane systems to the existing MMA primer coat was generally poor.

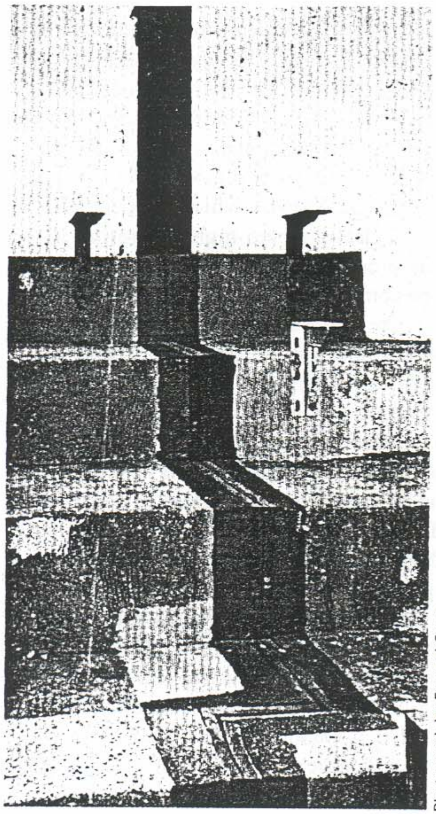
MMA was originally ruled out as a possible option due to the perceived ineffectiveness of the original MMA to eliminate leakage. However, a review of field data indicated that expansion joints and unsealed cracks were the main sources of leakage. The application of an MMA waterproofing system specifically designed with aggregate for skid resistance was selected. Although there was no risk of incompatibility, more detailed treatment of cracks and other anomalies would be required due to the relative ineffectiveness of the MMA to bridge cracks or disguise defects.

Protective coating installed

The concrete surfaces were power-washed. A paste of the MMA flexible sealer with a thixotropic additive was mixed and applied to the bughole areas. When MMA was applied to other coats of MMA, a chemical fusion of the two layers resulted. A primer coat was applied to concrete repair areas, worn areas, and traffic aisles. A base coat with pigment was applied at a 25 mil thickness and 50 mesh silica aggregate was broadcast over the surface until rejection. The excess aggregate was removed after the material had cured for 45 minutes. A pigmented top coat was then applied, adding 12 – 14 mils to the coating system. Aggregate was rebroadcast to areas needing additional traction.

Existing problems corrected

To solve structural and leak problems, the project team used a variety of remedial techniques. Zero-slump dry-pack concrete was trowel-applied into 400 repair areas totaling 350 square feet (33 m^2). The repairs were wet-



Photograph by Emseal Corp.

An installed joint remains continuous over a variety of turns.

cured in July when deck temperatures reached over 100° F (38° C). This process promoted even curing and controlled cracking due to shrinkage. Rapid-curing polymer-modified concrete was placed in the expansion joint blockouts. The material could only be used in these locations because it was not compatible with the MMA coating.

Low-pressure epoxy injection was used to repair full and partial depth cracks to increase the waterproofing integrity of the concrete deck. Other cracks were routed and sealed.

New trench drains were installed into the lowest step of each vomitory. Floor drains were installed on the interior slabs where ponding occurred. New exhaust fans were placed in the rear of the crawl space underneath the stands to draw out the excessive moisture from condensation.

Award-winning project

The White Stadium restoration was recognized in the 1996 ICRI New England Chapter concrete repair awards. CBI Consulting Inc. was presented the "Outstanding Project Award" which distinguishes a successful New England area project completed within the last five years.❐

Michael S. Teller, A.I.A, is a Senior Associate of CBI Consulting Inc. and has been practicing architecture in the Boston area for 19 years. His philosophy is that the marriage of structure and form result in the finest architecture; architects should stress mastery of technology; and successful projects are due to a team concept inclusive of all participants.

White Stadium Waterproofing

Owner
City of Boston
Public Facilities Department
Boston, Massachusetts

Project Designer
CBI Consulting, Inc.
Boston, Massachusetts

Contractor
Folan Waterproofing, Inc.
South Easton, Massachusetts

Material Suppliers
Righter Corporation–Silikal
Wilmington, Massachusetts

Emseal Joint Systems, Ltd.
Westborough, Massachusetts