

Shotcrete Finds a Home at the New Home of the Detroit Lions

by Scott Rand



Early work on the old Hudson warehouse



Condition of the two 1920s-era buildings

For 26 years, the Detroit Lions called the Silverdome in Pontiac, MI, their home. In August of 1996, however, the Lions announced plans to build a new \$500 million stadium in downtown Detroit, adjacent to the new Comerica Park, home of the Detroit Tigers. Voters in Wayne County overwhelmingly approved by referendum to fund the construction of the stadium. In November 1999, the Lions hosted a ground-breaking ceremony in which plans for the stadium were presented and the name Ford Field was announced.

In April 2000, the Lions awarded contracts to build the major portion of the stadium to a joint venture between Hunt Construction Group of Indianapolis and Jenkins Construction of Detroit. White/Olson, LLC, were awarded the contract to reconstruct the old Hudson warehouse buildings, which would span the entire south wall of the stadium.

The old warehouse buildings comprising two 1920s-era structures, which once served as a repository for fine linens, furniture, and light fixtures, were originally built by Hudson's Department Store, which closed its downtown operations in 1982. Plans for the renovated warehouse included more than 115 luxury suites on three levels where football fans could view a game in luxury surroundings. The suites, along with supporting kitchens and bathrooms, would occupy roughly 1/4 of the original warehouse space.

A main corridor between the two warehouse structures was reserved to allow for the construction of a seven-story glass atrium, which would serve as a south entrance to the stadium and allow for natural light to enter the building. Another 120,000 ft² (11,148 m²) of space was reserved for private offices, some of which would overlook the field. The warehouse was also designed to house the stadium press box, restaurants, lounge areas, banquet facilities, entertainment venues, and commercial space.

The poor condition of the original warehouse's seven-story concrete structure required that the concrete columns and beams undergo extensive repair and rehabilitation. SmithGroup, Inc., of

Detroit, the project managers/engineers, originally specified a “form and pump” method of repair. Scheduling pressures and concerns about extremely cold temperatures during construction, however, forced the general contractor to investigate other options that would contribute to the acceleration of the construction process during the winter months. It was critical that the project be completed before the Detroit Lions were scheduled to play their first preseason game against the Pittsburgh Steelers in August 2002.

Western Waterproofing Co. of Livonia, MI, was awarded the subcontract to undertake the concrete repairs. Western approached King Packaged Materials Company to help provide a solution to the cold temperature concerns. King’s MS-D3 Accelerated Shotcrete, which had been used successfully in sub-zero temperatures at Falconbridge’s Raglan Mine in the Canadian Arctic, was submitted by Western and approved by SmithGroup, Inc.

King’s technical staff explained that the principle by which MS-D3 Accelerated Shotcrete material is allowed to develop strength is based on the heat generated during the hydration process. This heat generation occurs rapidly after final set due to the effect of specialized preblended accelerators and high early strength (Type 3) cement. This process is further enhanced when the temperature of the materials is maintained above 50 °F (10 °C), and the temperature of the water is maintained between 70 to 80 °F (21 to 27 °C). Strength gain under these conditions will exceed the minimum 500 psi (3.5 MPa) threshold required to avoid future strength loss from freezing. At this point, the degree of saturation of the shotcrete matrix has dropped below the critical value and hydration will continue to occur at a slower rate, even at below freezing temperatures.

Based on the aforementioned information, the following specific procedures were recommended to ensure optimum performance of the shotcrete material:

1. Shotcrete must not be applied when ambient temperature is below 20 °F (-7 °C) or is expected to fall below 20 °F (-7 °C) within 6 hours following the application of shotcrete;
2. The receiving surface must be clean, free of contaminants, and the surface dry;
3. The temperature of the receiving surface must be a minimum of 20 °F (-7 °C);
4. Shotcrete materials must be maintained at a minimum temperature of 50 °F (10 °C);
5. Mixing water temperature must be maintained between 70 to 80 °F (21 to 27 °C); and
6. A resin-based liquid membrane curing compound approved for use in cold weather conditions should be applied immediately after shotcrete reaches final set.



Shotcreting the columns of the old structure



Inside view of southern elevation roof trough prior to shooting



Overview of north elevation showing the roof trough



Overview of north elevation showing the roof trough



Further progress of the Hudson warehouse buildings



South elevation roof trough, prior to shooting

Contrary to normal shotcrete applications where the receiving surface should be kept saturated-surface dry (SSD), it was recommended that the receiving surface be left dry to avoid freezing of the interface between the shotcrete and the parent concrete. Absorption of moisture from the initial layer of shotcrete into the parent concrete is less of a factor due to the cold temperatures.

NTH Consultants Ltd. of Detroit, acting as a representative of the owners, monitored site conditions to ensure that all recommendations, including temperature parameters, were followed. To ensure material temperature parameters were met, Western Waterproofing Co. stored the prepackaged shotcrete material in their heated warehouse and transported the material requirements to the job site daily. A small, temporary on-site storage facility was also heated. An inline water heater was used to ensure that the water temperature remained above the minimum, recommended 70 °F (21 °C).

Prior to approval, NTH Consultants Ltd. recommended that an evaluation program be conducted to confirm that the proposed system would provide acceptable results. A test panel was shot (24 x 24 x 4 in. [610 x 610 x 100 mm]) and cores were retrieved to provide a minimum of two compressive strength values at 1, 3, 7, 14, and 28 days. A test column was then chosen in which four thermocouples were installed to monitor the temperature of the critical areas (one in the existing column, one at the interface between the shotcrete and the parent concrete, one within the shotcrete itself, and one to monitor ambient air temperature). At 24 hours, two bond strength tests were conducted to verify that satisfactory bond strengths could be achieved. The success of the evaluation program led to the acceptance of the proposal and Western Waterproofing was given the OK to proceed.

Western used ACI-certified nozzle men on the project and the quality of the application was evident when, despite extremely difficult conditions, all repair areas exceeded the minimum specified requirements and ultimately contributed to the timely completion of the Hudson warehouse rehabilitation.

Further into the construction schedule, Western Waterproofing Co. was again called in to provide an alternative recommendation to a form and pump application on the roof of the stadium. The original specification called for a 4 in. (100 mm) layer of concrete to be pumped approximately 100 ft (30 m) above ground level along the inside surface of two large steel troughs. These troughs housed the heating cables, which were designed to prevent the build-up of ice and snow on the roof of the stadium.

Western Waterproofing again recommended that King MS-D1 Shotcrete be substituted for the



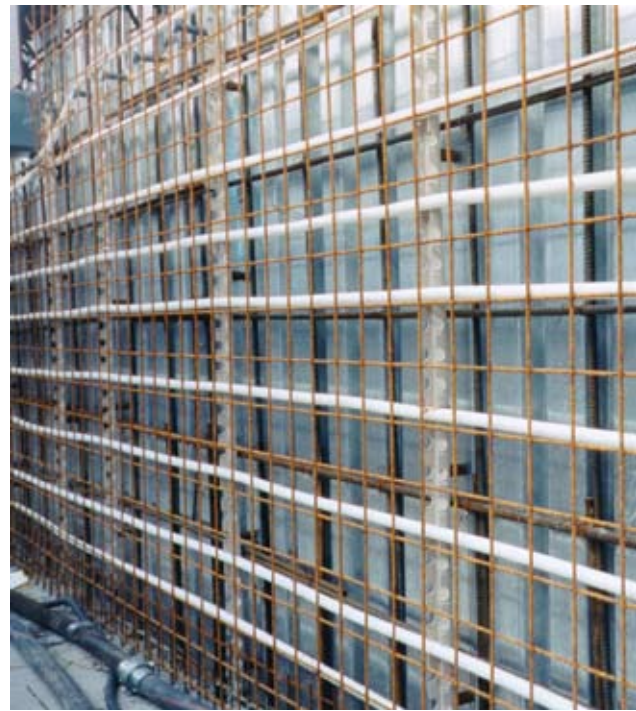
Inside view of Ford Field during construction



Southwest entrance of the stadium



Southern trough above the old warehouse section



Close-up of trough prior to shooting

specified concrete lining. This dry-mix shotcrete material allowed Western technicians to pneumatically convey material vertically, over 100 ft (30 m) to the two 500-plus ft (152 m) long troughs above the stadium floor. The hardened properties of the MS-D1 shotcrete material exceeded those of the specified mixture and ultimately over 275 yd³ (210 m³) of King MS-D1 shotcrete was used to complete the lining of the two steel troughs.

The success of shotcrete on the Ford Field Project was evident by the performance of the Western Waterproofing crews, but it was ultimately overshadowed for football fans worldwide by the performance of Pittsburgh Steelers who defeated the Seattle Seahawks 21-10 in Super Bowl XL earlier this year.



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