

Lifeline Foods Mill Building Renovation

The Lifeline Foods Mill building is a 10-story cast-in-place (CIP) structure with brick masonry infill at the exterior façade, built in 1929. The structure is a two-way flat slab floor with perimeter beams and drop panel with conical column capitals. There is approximately 16,000 ft² (1485 m²) per floor on each of the 10 floors. The plant had grain milling/food processing equipment on all floors, including approximately 180 floor perforations that were up to 16 ft (4.9 m) in diameter. The structure had some deteriorated concrete at the beams, columns, walls, and floors but was mostly sound. The epoxy floor and wall coating systems displayed significant peeling and delamination. This portion of the facility had not been used for many years; it was essentially abandoned, with the equipment left in place, as the mill changed processes and products.

The building owner partnered with the leading designer/builder of Ethanol plants to find an adaptive reuse for this aging facility. The founder of the Ethanol firm had a vision to make this underused facility the hallmark of the Ethanol industry. The vision was to take the structure and build a mill that would process the grain (corn) into food-grade materials for human consumption and make ethanol from the left-over material, leaving no portion of the grain unused. In addition to the mill, a fully functioning Ethanol plant, research laboratories, and a pilot plant were added. The intent is to use this plant as a milling research facility for Ethanol production. Scientists can experiment with laboratory bench-scale experiments; expand them

into pilot plant experiments; and, finally, modify an operating plant to check their process at full scale.

An emerging milling design firm was chosen out of Houston, TX, to design the milling equipment arrangement; and an engineering firm based in Wichita, KS, was chosen to be the Structural Engineer of Record due to their experience in grain facilities and Ethanol plant design. It was determined that only floors four through 10 were needed for the milling equipment. Floors one through three continued to be used for maintenance and storage. The structural engineers then took the existing plans and all of the old perforations and overlaid the new perforations on the plans. Samples of reinforcing steel were taken and tested for strength and welding compatibility. Much to the surprise of the engineers, the reinforcing was consistent with a higher grade steel and could be welded without special precautions. The reinforcing was also deformed square bars that were fairly new. Another issue that is rarely a structural consideration was sanitation, because this was a food-grade facility. To control vermin, the facility must be heated to 130 °F (54 °C) and held for several days four times a year. Also, there cannot be any crevasses that shelter vermin or shelves that allow dust to accumulate.

Design Considerations

The design team began with repairs to the existing openings, including removing some interior beams that conflicted with the new equipment (previously, some interior beams were used in areas with the bins that penetrated several floors). After the repair design was complete, the team began the design for the new equipment loads and new perforations.

It quickly became apparent that significant reinforcing was required due to the number of reinforcing bars that had been severed in the 76 years the facility had been in use. The alternate choices considered were steel plate external reinforcing, bonded concrete overlay with reinforcing (above and beneath the floor), and external fiber reinforcing. Because this facility was going to be a state-of-the-art showpiece in premilling Ethanol production, external steel reinforcing was not chosen. The concrete overlay was seriously considered; but due to height restrictions with the new equipment, it was discounted. The external fiber reinforcing was the most cost effective. The engineer designed the carbon fiber and



Exterior of 10-story plant

laid the strips away from the new equipment. Fiber on was carefully cut into the top surface of the concrete and then covered over with a topping or coatings. Fiber on the bottom surface was left exposed and then painted over. The final result was a clean look that met the design needs of the client.

Areas that were to receive very heavy tanks were dealt with by building cast-in-place beams over the existing slab (up-turned beams) that resulted in a clean surface to mount the tanks and prevent vermin hiding locations. The ends of the slabs were tied into the columns.

Scope of Project

The plant conversion required the following:

- Removal of all of the old grain processing equipment;
- Repair of deteriorated concrete;
- Reinforcing and filling of all original floor perforations;
- Coating removal from floors, walls, and ceilings;
- Interior and exterior masonry repair;
- CIP structural concrete beam and floor removal;
- Significant structural concrete fiber-reinforced polymer (CFRP) installation;
- New structural floor in-fills and new concrete overlays;
- New reinforced upturned beams; and
- New coatings installation.

Deterioration and failure types included excessive floor and beam loading, chemical corrosion on level eight, nonbreathable coating systems combined with excessive system buildup and delamination, and poor concrete repair product selection and installation. As demolition continued, more defects were found after toppings had been removed.

Due to the complex arrangement, quantity, and type of perforations or defects, the repairs needed many different materials. The repair systems included carbon-fiber reinforcing; various mixture designs of ready mixed concrete products; high-performance, prepackaged, cement-based patching products; bonding admixtures and bonding epoxies; high-performance wall and floor coating systems; and joint sealants.

Repair Work Begins

The original plant milling and processing equipment was removed along with all mechanical, electrical, and plumbing utilities on floors four through 10. During this removal process, the original floor coatings, ceiling coatings, floor tile, steel beams, steel columns, embedded steel sleeves, anchor bolts, and deteriorated concrete were also removed. In addition, over 90 large reinforced concrete beams were removed along with another 8000 ft² (745 m²) of full-depth concrete floor.

Removal methods varied based on the type of material encountered. The floor and ceiling coatings



Demolition of interior beams



Large diameter tank supports

used a combination of hydrodemolition, steel shot blast, self-propelled riding floor scrapers, pneumatic floor scrapers, and pneumatic air hammers. Where needed, concrete slabs were removed by hydrodemolition or pneumatic air hammers. After the slab was removed, the remaining beams were removed with either a hydraulic beam crusher or a diamond chain saw. New perforations varied from small to large holes (8 in. to 17.5 ft [20 cm to 5.3 m] in diameter). The smaller holes were made with core drills. Large holes were cut with a diamond-encrusted cable saw, sectioned with diamond chain saws into manageable sizes, and hoisted using lifting anchors drilled into the slab.

Surfaces to receive new coatings or toppings were prepared by hydrodemolition, steel shot blasting, sandblasting, or controlled pressure water blasting, depending on the coating and the substrate hardness.

All of the repairs were performed in accordance with plans and specifications prepared by the engineer. The engineer also specified that a representative would verify the initial installation with certified installers for the carbon-fiber reinforcing. The installers of carbon-fiber reinforcing were site-specific trained and certified by the product manufacturers' representative. Surveyors laid the locations of all perforations out on the slabs to



Floor perforations being built

provide a guide for the carbon-fiber installers. Adhesion of the carbon fiber and toppings were verified using Elkometer test pulls and adhesion testing. A special structural inspector was present to monitor the training and product installation during performance of the work.

During the demolition, many embedded steel items within concrete floors, hundreds of old cement-based patches beneath floor coating systems, deteriorated concrete on exterior and interior beams and ceiling surfaces, and delaminated concrete toppings and floor coating systems were found. The owner, while not happy with finding new defects, was very intent on getting the project done correctly.

Project Success

The sheer quantity of perforations and deteriorated concrete materials to be removed prior to commencing structural repairs was enormous. Over



CFRP installed in ceiling

15,000 ft (4472 m) of new CFRP was eventually installed to repair the slabs. Over 600 floor perforations from 8 in. to 17.5 ft (20 cm to 5.3 m) in diameter were added. Approximately 80,000 ft² (7432 m²) of new bonded concrete topping was added. Over 8000 ft² (745 m²) of reinforced concrete full-depth floor repair was constructed. Approximately 145,000 ft² (13,471 m²) of new epoxy wall and ceiling coatings were installed. Three 17.5 ft (5.3 m) diameter reinforced concrete upturned

Lifeline Foods Dry Mill

Owner

Lifeline Foods
St. Joseph, MO

Project Engineer/Designer

Professional Engineering Consultants
Wichita, KS

Repair Contractor

Concrete & Masonry Restoration
Kansas City, MO

Materials Suppliers/Manufacturers

Sika Corporation
Lyndhurst, NJ

The Sherwin-Williams Company
Kansas City, MO

Subcontractor team members and project scope:

American Hydro: Partial- and full-depth concrete hydrodemolition and epoxy coatings removal from horizontal and overhead surfaces.

A.T. Switzer Painting Company: Wall and ceiling specialty coatings applications.

City Cement Company: Structural CIP up-turned beam installation, concrete floor overlays, and new CIP structural floor installation.

DH Restoration Company: Overhead concrete patching.

InFranca Technologies: Ride-on floor scraper coating removal.

Jacor Contracting: Carbon-fiber reinforcing, concrete floor overlayment, and caulking.

KC Cutting and Coring Group: CIP beam removal, CIP structural floor slab sawing, and coring and cutting of floor perforations.

Larkin Contracting Company: New CMU wall construction and brick and CMU masonry.

Safeway Scaffold Company: Shoring and swing-stage scaffolding installation.

Western Roofing Company: Installation and removal of interior temporary roof system for hydrodemolition effluent management.



New floor with perforations ready for equipment

beams were cast to support new tanks. New interior concrete masonry unit (CMU) walls were added for the control room, laboratories, compressor room, and electrical rooms. With all major endeavors, a large team of designers and contractors worked diligently to give the owners their best efforts and the result was a well constructed, functional project.



Looking up through bin holes in new floor slabs