Withstanding Excessive Loads

Chicago rail yard expansion includes underground storm water management system

By Steve Cooper

Two old industrial parks in Chicago were converted into rail/truck intermodal yards to accommodate increasing freight traffic in and around the city and the region. Due to sandy soil and other considerations, a series of detention systems was constructed to provide the storm water drainage that was required for the yards. The designs for the systems were not typical due to the extreme weight of the railroad cars that would pass over the pipe—rail car loads can exceed 250,000 lb—and the variable depths of cover throughout the installations. High-density polyethylene (HDPE) pipe was useful to the projects because of the pipe's ability to withstand the massive live loads from the containers and fork trucks that load and unload the trains, and its proven structural capacity under Cooper E80 loading conditions. Additionally, because HDPE pipe is lightweight, there was no concern about the pipe settling over time in the sandy soil.

Heavy Lifting

The two projects were conducted during 2011 and 2012 at separate intermodal rail yards located a few miles south and west of Chicago. Both facilities transfer freight from one transportation mode to another—trains to trucks—without handling the freight itself.

The 47th Street Intermodal yard was a major construction and drainage project to reconfigure the entrance into the facility off Garfield Avenue. The HDPE pipe used on the project improved the existing drainage for the entire southern half of the yard. The pipe lies beneath 13 ft of cover in some areas and is under chassis storage and parking.

The 63rd Street project is a complete drainage upgrade to the entire 140-acre facility. Due to sandy soil, the 63rd Street yard experienced problems with drainage, and the HDPE pipe was used in a series of detention systems throughout the entire facility. These detention systems are underneath the loading and unloading areas for inbound and outbound freight trains. The HDPE detention systems also are beneath all of the drive aisles and chassis storage areas. The yard currently handles 480,000 containers a year, with 12 inbound and 10 outbound trains, seven days a week.

"HDPE pipe was [ideal] for both of these projects due to the massive live loads, the weight of the container and its handler, which can be 251,000 lb," said Daniel Currence, P.E., director of engineering for the Plastics Pipe Institute Inc.'s (PPI) Corrugated Polyethylene Pipe Assn. division. PPI is a trade association representing the plastic pipe industry.

"After running the Load Resistance Factor Design calculations for the potential loads on both sites, it was determined that the pipe would meet and even exceed the loading requirements," Currence said. "The southeast Chicago rail yard projects are proof that HDPE will not have issues with heavy live loads—even rail loading that is around 80,000 lb per axle. This weight is well above the standard AASHTO (American Association of State Highway and Transportation Officials) H-20 or H-25

Left: Large-diameter corrugated HDPE pipe waiting to be installed at a depth of 13 ft.

Below: The benefits of using corrugated HDPE pipe include its light weight, corrosion resistance, low cost of construction and structural capacity under Cooper E80 loading conditions.

loading that would be experienced under a road or typical parking lot."

The corrugated HDPE pipe used is called N-12 and is made by Advanced Drainage Systems Inc. (ADS).

For both projects, approximately 10,000 ln ft of HDPE pipe, ranging from 8- to 60-in. diameters, with the majority being 24-in. diameter, were used. According to the PPI, corrugated HDPE pipe is known for its ability to resist chemicals, road salts, abrasion and repeated freeze/thaw cycles. The pipe's strength is due to its design, HDPE resin and manufacturing process. The structural integrity of corrugated HDPE pipe can be validated using the design procedures outlined in the AASHTO LRFD (resistance factor design philosophy) Bridge Design Specifications. AASHTO LRFD Section 12 is a strain-based design procedure suitable for thermoplastic pipe such as HDPE, polypropylene and PVC. The AASHTO LRFD code considers the actual failure modes of thermoplastic pipe such as thrust and wall buckling, as well as combined strain to ensure a viable design. Deflection is considered as a service limit and serves as confirmation of the design, ensuring suitable long-term performance.

Tested Benefits

"These railroad-related drainage projects also further support the FAST [Facility for Accelerated Testing]/AREMA [American Railway Engineering and Maintenance-of-Way Assn.] study regarding the successful test and use of corrugated HDPE pipe under heavy rail cars," said Tony Radoszewski, president of PPI. "The use of corrugated HDPE pipe by the railroad industry has continued to increase during the past few years. This is due to many successful trial installations of HDPE pipe and a significant independent industry study, as well as the recent addition of HDPE pipe to AREMA manual."

The study Radoszewski referred to was funded by PPI and evaluated the successful use of corrugated HDPE pipe beneath heavy rail car loads with shallow cover. The test was conducted by the Transportation Technology Center Inc. at FAST in Pueblo, Colo., where it operates a test bed for railroad track. The methodology of the project included repeatedly running a train consisting of four locomotives with 80 315,000-lb rail cars over 48-in. corrugated HDPE pipe with 4 ft of cover from the top of the pipe to the bottom of the rail. In addition to the dynamic performance evaluation, the long-term impact of heavy static loads on the pipe was assessed by parking the cars with one set of wheels on the track directly over the same pipe for six weeks.

"The culvert section of the AREMA manual includes standards and specifications for the use of corrugated HDPE pipe in 3- to 60-in. diameters for under track culverts and [in] storm drain applications," Currence said. "AREMA references for corrugated HDPE storm drainage pipe can be found in the April 2012 AREMA Manual, Chapter 1 (Roadway and Ballast), Part 4 (Culverts). This industry resource assists design engineers in reducing costs and increasing project longevity."

"With rail cars and locomotives weighing hundreds of thousands of pounds, it was critical that the proper studies be conducted and the pipe validated by a trusted industry resource," Radoszewski said. "Now we're seeing the major rail companies, including Amtrak, Union Pacific, CSX, BNSF and Norfolk Southern, using corrugated HDPE pipe since the pipe's inclusion in the AREMA manual."

In fact, Radoszewski said, Norfolk Southern used about seven miles of HDPE pipe in 2012 for the underground drainage system at its new Memphis Regional Intermodal Facility. After the project was completed, it found that the pipe reduced costs, increased efficiencies and added longevity to a facility that will be heavily traveled and subjected to hundreds of tons of weight from above; in addition, it helped the system comply with state and federal water quality regulations.

"The benefits of using corrugated HDPE include improved corrosion resistance, favorable cost of construction and proven structural capacity under Cooper E80 loading conditions," Radoszewski said. "We fully expect the trend to accelerate as repairs and expansion of the rail lines continue." iWWD

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