

## Engineers' Considerations for Avoiding Flexible Pipe Problems

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On September 21, 2012, a sinkhole formed on McGregor Boulevard at Olmeda Way in Fort Myers, Florida revealing a collapsed 30-inch diameter, Type S wall high-density polyethylene (HDPE) storm pipe. The failure occurred nearly one year following the City's replacement of an 18-inch diameter Type S wall HDPE pipe with reinforced concrete pipe (RCP) along McGregor Boulevard near Stadler Drive. The HDPE storm sewer has reportedly been failing, since it was initially installed by the Florida Department of Transportation in approximately 1999. In-situ conditions appear typical for Florida storm sewer installations. Historically, the City of Fort Myers experiences conditions where the natural groundwater elevation fluctuates and is generally two to three feet above the pipe crown. Pipe depth is approximately six feet from the pipe crown to roadway surface.<sup>1</sup>

It appears that the asphalt pavement was "bridging" a large void that had eroded due to the failed 30-inch pipe. Upon excavation, samples of the failed 18-inch and 30-inch HDPE pipe showed signs of longitudinal cracking through the walls along the invert and obvert. Longitudinal cracks traversed the springline of the outer corrugations, and circumferential cracks were observed in the inner liner at the junction with the outer corrugation. The HDPE material of both failed pipes appeared brittle and the corrugations and bell could be easily manipulated by hand, suggesting the pipe's initial material properties may have diminished.<sup>2</sup>

*Some may speculate that an HDPE pipe failure is simply the result of a poor installation, but there are often other factors that play a critical role.*<sup>2</sup> While proper installation is critical for an HDPE pipe to structurally perform without exceeding a five percent deformation limit, it is also essential that professional engineers actively engage in the design, specification, and inspection of the flexible pipe installation.<sup>3</sup>

In the case of a separate pipe failure documented in *Greenfield Place Stormwater Investigation in Deerfield Township, Ohio*, the consulting engineer and HDPE pipe manufacturer apparently concluded that the contractor may have been responsible for HDPE pipe collapses.<sup>4</sup> However, in other failures, professional engineers had significantly more financial liability than the underground utility contractors. In the case of the INCA storm water and water main project in Boynton Beach, Florida, the contractor was awarded \$1.2M from the consulting engineer in a legal dispute.<sup>5,6</sup> In the aftermath of the East Texas Fish Hatchery HDPE storm pipe failure, the consulting engineer settled for \$3.3M in favor of the Texas Parks and Wildlife Department and the contractor.<sup>7</sup> The 2007 failure of corrugated HDPE storm pipe collapsed sections of the parking lot during construction of the Gateway Shoppes in Naples, Florida.<sup>8</sup> Subsequent litigation involving the developer, contractor, and engineer was not disposed until November 2010.<sup>9</sup>

As a general rule, flexible thermoplastic pipes are essentially liners that can lack the stiffness to support service loads unless properly installed within an engineered soil embedment. Strength certification of flexible pipe installations is a comprehensive process that should include engineering design for buoyancy, strain, deflection at service loads, and buckling resistance using long-term material properties, verification of geotechnical / groundwater conditions, actively managing proper installation, and post-installation inspection for deformation and other failure modes. Otherwise, the community, owners, contractors, and engineers are at risk.

1. On-site observations and discussions, Sept. 14 – 15, 2011.
2. On-site observations and discussions, September 24, 2012.
3. This example is noted only for illustration and discussion purposes. No opinion is offered as to any specific cause of the conditions noted in this example.
4. *Greenfield Place Stormwater Investigation, Deerfield Township, Ohio*, Report by Camp, Dresser, and McKee for the Deerfield Regional Storm Water District, May 2007.
5. Letter to Town of Golden Beach, Florida from Ric-Man Construction regarding Capital Improvement Program Project # 734-01, dated May 15, 2008.
6. Meeting with City of Boynton Beach, Florida, September 3, 2009.
7. HDPE Design and Construction: Lessons Learned from the East Texas Fish Hatchery Incident, American Concrete Pipe Association, Resource # e-011, April 2011, <http://www.concrete-pipe.org/pages/epipe.html>
8. Field observations at vicinity of Gateway Shoppes development in Naples, Florida, August 2007.
9. Uniform Case Number 112008CA0017320001XX, Collier County Clerk of the Circuit Court, Public Inquiry, [http://apps.collierclerk.com/public\\_inquiry/Case.aspx?UCN=112008CA0017320001XX&CT=CV](http://apps.collierclerk.com/public_inquiry/Case.aspx?UCN=112008CA0017320001XX&CT=CV).

18-inch concrete pipe replaces 12-year old HDPE pipe installation, September 15, 2011.

18-inch HDPE pipe was deformed one inch (5.5%) and had developed longitudinal cracks, Sept. 15, 2011.