HDPE Berm Pipe Aperture

Version 2.0 12/5/2011

Michael Geelhoed

Introduction

In the spring of 2011, the berm pipe from enclosure G2 to NM1 developed a significant leak. Vacuum pumps were destroyed when ground water infiltrated the quarter inch thick steel wall pipe. After months of troubleshooting and surveying, the idea to sleeve this pipe using High Density Polyethylene, or HDPE, pipe is considered.

One aspect of the pipe to consider is the aperture restrictions that this pipe would create. There are three factors to determine the aperture. The initial diameter creates a smaller aperture. The calculation of the sag of the HDPE as it spans across the three transitions in the existing berm pipe. The pipe will lose some of its aperture due to its initial sag, but also as a function of time that sag increases, called creep.[[1]](#footnote-1)

For this test we arrange to have a section of HDPE be sliced in multiple sections and fused back together using the same method for final installation. Another test was performed to have one solid section of HDPE pipe tested for its creep for comparison. The HDPE in consideration is DR11 14” HDPE. With an outside diameter at 14”, it has an average standard wall thickness of 1.27 inches and weighs 22.2 lbs/ft. The three transitions are in two different lengths, 2 of them are 60 feet long and the middle transition is 40 feet. The pipe changes in diameter from 15.25” to 29.25” pipe making the difference in the inverts in 7 inches.

Measurement and Data

The first piece of fused together HDPE of total length twenty one feet was spanned between two pipe stands eighteen feet apart. Both ends of the HDPE were not fixed and were able to counter-rotate to the sag. The raised piece of HDPE on stands was measured at the center of the pipe where the creep would be most evident.

The starting measurement at the center of the pipe was 38.5 inches to the floor. In two hours, the pipe was measured again at the center; its height was 38 inches to the floor. Two more measurements were taken after the pipe was initially placed. Shown in the figures below, the HDPE pipe has lowered by one and a quarter inch in twenty four hours.

Figure 1 Plot of sag elevation change of the fused together HDPE pipe for 24 hours

Using a piece of fused together HDPE, it was recommended that the weld joints would be strong as or stronger than the original pipe itself.[[2]](#footnote-2) The test was stopped after twenty four hours; the first reason was last measurement at twenty four hours showed that creep was a certain factor in preparing to use HDPE. Another unfortunate reason was that during the vacuum check of the HDPE, the pipe was inadvertently rotated within the pipe stands. Every measurement past twenty four hours would have been corrupted data.

A second piece of HDPE was procured and delivered to the NM4 hall. At NM4, this twenty five foot section of one piece HDPE was spanned across two pipe stands. Using the same method of measuring the elevation change as a function of time, the results are plotted in Figure 2.

Figure 2 Plot of elevation change of single piece HDPE

 Below is the equation for the deflection at the midpoint of the pipe, where δ is the deflection, q is the force applied evenly across the pipe, L is the length between the two points of support, E is the Modulus of Elasticity and I is the moment of inertia:[[3]](#footnote-3)

$$δ = \left(\frac{5×q ×L^{4}}{384×E×I}\right)$$

Solving for E:

$$E=\left(\frac{5×q ×L^{4}}{δ ×384×I}\right) $$

 Figure 3 shows the calculated Modulus of Elasticity of the HDPE pipe versus time.

Figure 3 Plot of sag change (creep) of single piece HDPE

Conclusion

 Sag in the HDPE pipe is a key factor when calculating the aperture of this pipe. Calculating the creep in HDPE is also an important factor. However, it is inconclusive with the present data set to compare a fused section of HDPE with one that isn’t.

 With the data that we do have, creep does affect the aperture of this DR11 14” HDPE pipe over its normal weight with no added force acting on the pipe. If taken the last calculated Modulus of Elasticity, 127,000 psi, to a 40’ section of HDPE, its deflection will be greater than 8 inches. Therefore the HDPE pipe would sit on the bottom of the steel pipe in all of the transitions. In best case scenario the largest aperture is 4.3 inches.

1. Buried Pipe Design 3rd Ed. Moser and Folkman pg 96 [↑](#footnote-ref-1)
2. Private conversation with Jim Sparks, Mid America Underground [↑](#footnote-ref-2)
3. Mechanics of Materials, 3rd Edition, 1990 Gere and [Timoshenko](http://www.bookbyte.com/searchresults.aspx?type=books&kwd=Stephen%20P.%20Timoshenko) pg 774 [↑](#footnote-ref-3)