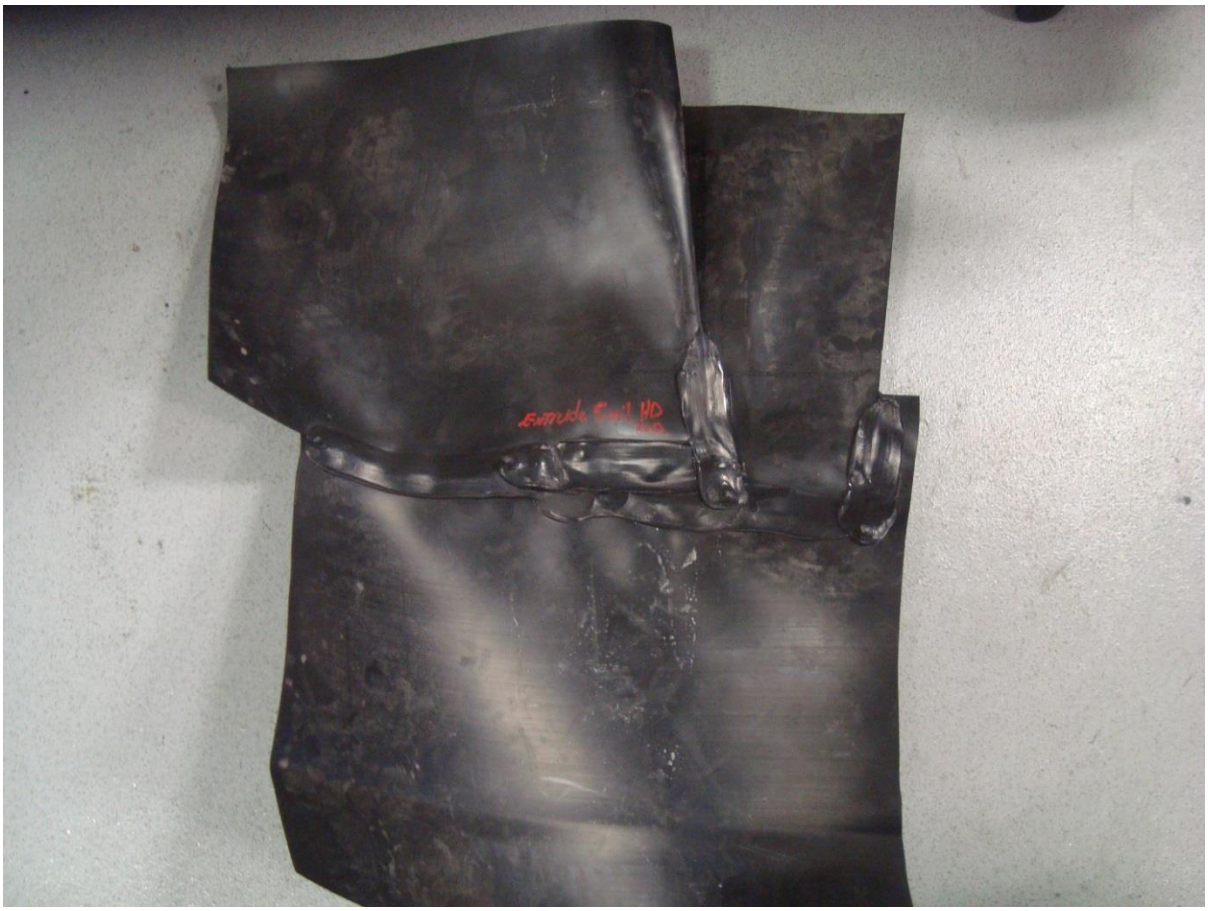
July 9, 2019

Extrusion Welding of Complex Shapes

Western Engineered Containment (WEC) is in discussions with a client who is trying to resolve leaks in a series of above ground lined tanks. The current lining method involves fabricating a polyethylene sheet liner into the cylindrical shape of the tank. As a result, effective seams at the junction of the wall and the circular base have been impossible. A reliable wedge weld cannot be done in an arc pattern, leaving less reliable extrusion welding as the industry practice. To accomplish this, the wall liner section extends a few feet onto the circular base liner to provide a flat surface for extrusion welding, but results in excess material gathering from the wall section of liner as a consequence. This material is pleated to complete the seam, and a complex shape needs to be extrusion welded as opposed to a standard single line. These complex welds represent the weakest construction points of the liner system.

WEC reproduced the extrusion welds of the pleated areas, making multiple samples. Some standard single line sections were also produced for comparison. 40 mil LLDPE was used as the liner, and 5 mm HDPE extrusion rod was used to make the welds. These seams were cut into 1' wide samples and peeled apart in layers to test their integrity. An Instron Tensile Tester was used to analyze the samples.



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Results:

Single Line Weld

Sample	Peel Strength (ppi)*	Extension at Break (mm)
1	75	460
2	77	120
3	75	105
4	66	75
5	58	50
6	71	150
Average	**71**	**160**

*PPI is lbs force per inch width

Pleated Weld, First Weld Bottom Layer (This is where the original 2 sheets are joined, the pleated section is folded a little behind and a little on top of this seam, resulting in 2 seams staggered a short distance from one another with overlap (see picture)).

Sample	Peel Strength (ppi)	Extension at Break (mm)
1	38	80
2	74	80
3	41	110
4	41	120
5	52	75
6	48	135
Average	**49**	**100**

Pleated Weld, First Weld Top Layer (peeling the top sheet of the first weld, from the rest of the mass)

Sample	Peel Strength (ppi)	Extension at Break (mm)
1	70	110
2	60	130
3	76	110
4	64	200
5	82	270
6	74	130
Average	**71**	**150**

Pleated Weld, (Peeling pleat apart)

Sample	Peel Strength (ppi)	Extension at Break (mm)
1	84	500
2	80	120
3	59	150
4	69	380
5	76	90
6	55	120
Average	**70**	**227**

Clearly the weak point of the pleated seams was peeling the very bottom layer of liner off of the initial weld. All other layers were consistent with a standard extrusion weld. The bottom layer averaged 49 ppi in peel strength but had one very high value, and 5 very low values amongst the six samples cut. The minimum published field extrusion weld peel strength is 44 ppi. 3 of the 6 samples of the bottom layer failed to meet this standard.

It is possible that the expansion/contraction stress on this seam from the heat and cooling of the pleat seam being placed beside and on top of it, weakens this layer of the weld. Expansion and contraction stress on polyethylene seams is an unavoidable consequence of welding seams of polyethylene lining systems.

Conclusion:

The extrusion welds, and especially the complex pleated welds used in the above ground tank application are the weak point in the lining system. WEC is an experienced polyethylene installer, however, the production of extrusion welds in this configuration that consistently met acceptable industry minimum standards proved to be unachievable.

The replacement of the polyethylene lining system and extrusion welds with a spray applied seamless system would provide a much greater probability of eliminating leaks in the system.

If you would like to discuss this analysis further or have any other questions please contact the undersigned.

Sincerely,

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