Leachate Collection Pipe Construction

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Permitting lateral and/or vertical expansions is the way for the landfill operators to remain in business, and that has resulted in permitted landfills becoming larger and taller. There are currently permitted landfills in the state of Florida or in other states with a maximum waste thickness exceeding 300 feet. Landfills with over 300-foot thicknesses may be rare, but there are many landfills with waste thicknesses over 200 feet in Florida. These landfills can apply significant compressive stresses on the leachate collection pipes placed below waste at the bottom of the landfill. Leachate collection pipes are considered the backbone for proper management of leachate in landfills. Without leachate collection pipes, leachate heads can quickly exceed the allowable maximum leachate head of 1.0 feet above the liner, and the agency would have to take action at that stage, possibly shutting down the landfill if leachate collection pipes are compromised to the point of not allowing flow through them.

Leachate collection pipes are generally made of high-density polyethylene (HDPE) resin. There are certainly extensive standards to make sure that pipes used for leachate collection systems meet the minimum reported values by the pipe manufacturer; however, HDPE pipes by themselves cannot resist the compressive stresses of 200 feet or more of waste above them. What makes it possible for HDPE pipes to survive under such high-compressive stress conditions is the gravel placed around the pipe. Extensive research by academia and industry has shown that gravel can bridge compressive stresses over and around the pipe and reduce the amount of compressive stress actually applied to the pipe if gravel is placed in a correct manner.

Placing the pipe over the lining system geosynthetics and then placing gravel over the pipe will not do the job. That type of construction has very high risks of the pipe collapsing under the compressive stresses, because gravel cannot bridge the stresses around the pipe. For proper bridging of the compressive stresses, gravel must encase the leachate collection pipe, which means gravel must be placed below and above the pipe. A minimum of 3 inches of gravel below the leachate collection pipe (Photo 1), in addition to gravel covering the sides and the top of the pipe (Photo 2), is a proper manner of construction to ensure compressive loads are not directly applied to the pipe but bridged around the pipe by the gravel encasing the pipe.

The encasing of pipe entirely in gravel is also supported by the empirical models established for analysis of pipe failure modes under compressive stresses. Normally, pipes are analyzed for three failures modes, namely wall crushing, wall buckling, and excessive ring deflection. At least two of these failure modes (i.e., wall bucking and excessive ring deflection) are affected by the modulus of soil reaction (E') of gravel around the pipe. Typical values for modulus of soil reaction are shown in Table 1 from the Bureau of Reclamation.

July 20, 2016 In Landfill Management,MSW Management Weekly
and MSW Management July/August 2016, Pages 70-72

Table 1. Values of Modulus of Soil Reaction (E')

Soil type-pipe bedding material (Unified Classification System)[1]	E' for degree of compaction of bedding (lb/in²)			
	Dumped	Slight <85% Proctor <40% relative density	Moderate 85–95% Proctor 40–75% relative density	High >95% Proctor >70% relative density
Fine-grained soils (LL>50)[2] Soils with medium to high plasticity CH, MH, CH-MH	No data available; consult a competent soils engineer; otherwise use E' = 0			
Fine-grained soils (LL<50) Soils with medium to no plasticity CL, ML, ML-CL, with less than 25% coarse-grained particles	50	200	400	1,000
Fine-grained soils (LL<50) Soils with medium to no plasticity CL, ML, ML-CL, with more than 25% coarse-grained particles Coarse-grained soils with fines GM, GC, SM, SC[3] contains more than 12% fines	100	400	1,000	2,000
Coarse-grained soils with little or no fines GW, GP, SW, SP[3] contains less than 12% fines	200	1,000	2,000	3,000
Crushed rock	1,000	3,000		

[3]

[1] ASTM Designation D 2487, USBR Designation E-3

[2] LL = liquid limit

[3]Or any borderline soil beginning with one of these symbols (i.e., GM-GC-SC)

As Table 1 shows, the value of E' depends on the gradation and degree of compaction of the pipe bedding material. Properly placed gravel and compacted or shaped in a tight manner will have a significant impact on protection of the pipe against wall bucking and excessive ring deflection.

[4]

Photo 2. Gravel formed around the pipe.

It is important for landfill engineers to show gravel below the pipe in their plans, and it is also very important for the construction quality assurance monitors to observe placement of gravel below the leachate collection pipe. Construction of the leachate collection pipe with gravel below the pipe may take a bit longer, but that little extra time drastically increases survivability of the pipe below high compressive stresses. Contractors need to have laborers available to form gravel properly around the pipe before closing the gravel with geotextile. Contractors must also be conscious about placement of the protective cover material over and around the pipe/gravel/geotextile burrito. Improper placement may disturb the gravel pack around the pipe to the point that gravel may not function as desired. Such conditions would be almost impossible to detect or assess as a cause of failure if and when the leachate collection pipe collapses below waste.

Survivability of leachate collection pipes highly depends on the gravel placed on all sides of the pipe. Proper placement of gravel around the pipe and the granular soil material over the completed pipe/gravel/geotextile burrito is of significant importance in the protection of the leachate collection pipe.