STATIC LOAD TEST ON LADTECH'S CONFINED, HIGH DENSITY POLYETHYLENE MANHOLE ADJUSTING RINGS

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1.0 INTRODUCTION

LadTech, Inc. (LadTech) designs and manufactures High Density Polyethylene (poly) manhole risers. LadTech asked AET to perform a static load test on a typical configuration of HDPE risers in a confined environment and measure deflection.

2.0 METHODOLOGY

LadTech provided American Engineering Testing (AET) with a cast-iron manhole frame and cover, two 2-inch HDPE risers, and one 4-inch HDPE riser. This manhole frame and risers are referred to as the *riser assembly* or the *assembly* throughout this document. The nominal diameter of the riser assembly was 36 inches outside diameter and 27 inches inside diameter. The load test occurred on January 24, 2024, at AET in Saint Paul, MN.

The manhole and rings were assembled on a piece of 3/16-inch thick steel plate, which was supported by a 2-inch-thick steel plate. Each poly riser has a ¾-inch lip edge that protrudes below the bottom of the flat surface for the purpose of guiding and locking it into either the manhole opening or another riser. To account for the ¾-inch lip, three, ¼-inch steel rings were placed on top of the steel plate and below the bottom poly riser so the lip was not the load bearing surface. The manhole assembly was centered within a 4-foot diameter cardboard tube, which confined compacted Class 5 material around the riser rings. Figure 2.1 shows the cast-iron frame, riser rings, and steel rings (difficult to see) within the cardboard tube. AET placed a 3/16-inch to ¼-inch bead of butyl caulk, supplied by LadTech, between the HDPE risers. This caulk was not placed between the steel support plate and bottom riser or between the top riser and the cast-iron frame.

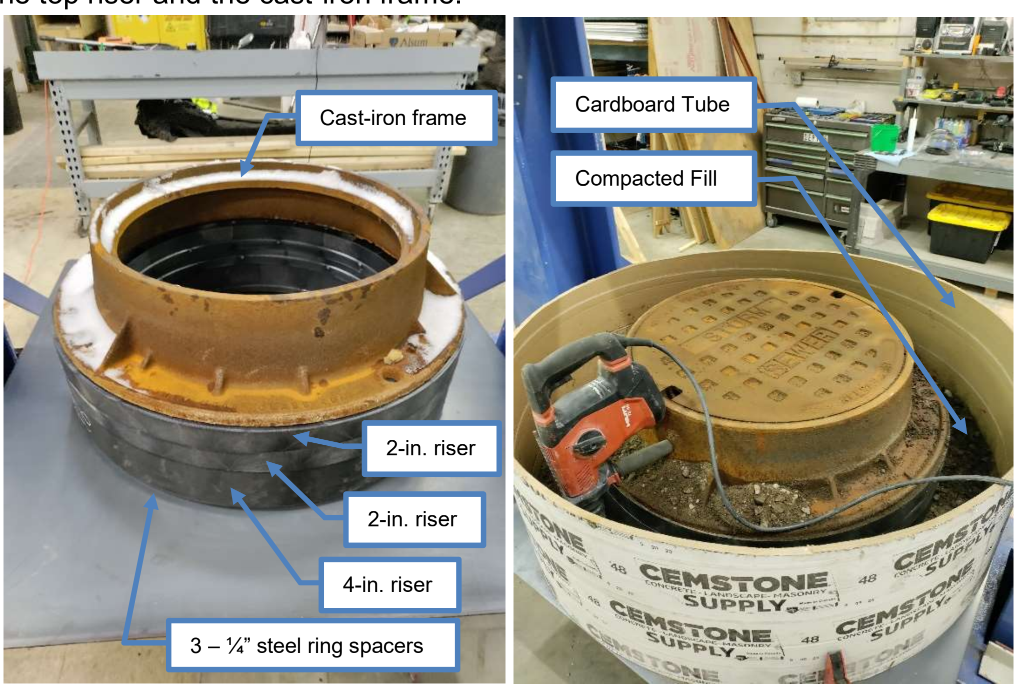

Figure 2.1: HDPE riser rings and casting before confining material was introduced

Recycled Class 5 material was introduced and compacted around the HDPE riser rings in 1-inch lifts. The material was densified by placing a 2-inch by 2-inch by 1-inch wood block on top of the Class 5 material and pounding it with a rubber mallet. A spray bottle was used to moisten the Class 5 as it was compacted to increase the material's density. Figure 2.2 shows the compacted Class 5 flush with the top of the riser rings.

Figure 2.2: Compacted Class 5 flush with the top of the HDPE risers

The cast-iron frame base was matched to the HDPE riser ring footprint, and the cast-iron cover was set into the frame. This is illustrated in Figure 2.3, without cast-iron cover in place.

Figure 2.3: Riser rings confined with compacted Class 5 and cast-iron frame and cover

A 10-inch by 10-inch by 1-inch steel plate was centered on the cast-iron manhole cover. A ram, spacer, and load cell were centered on the steel plate and connected to a hydraulic jack. A vertical load was imparted to the plate by a ram connected to a hydraulic jack. The ram reacted off a steel reaction frame that was bolted to the concrete floor. The load on the jack was controlled by a hydraulic pump operated by AET. The load imparted by the jack on the steel plate was measured by a load-cell that was connected to a monitor that indicated the applied load. Figure 2.4 shows the components of the load test.

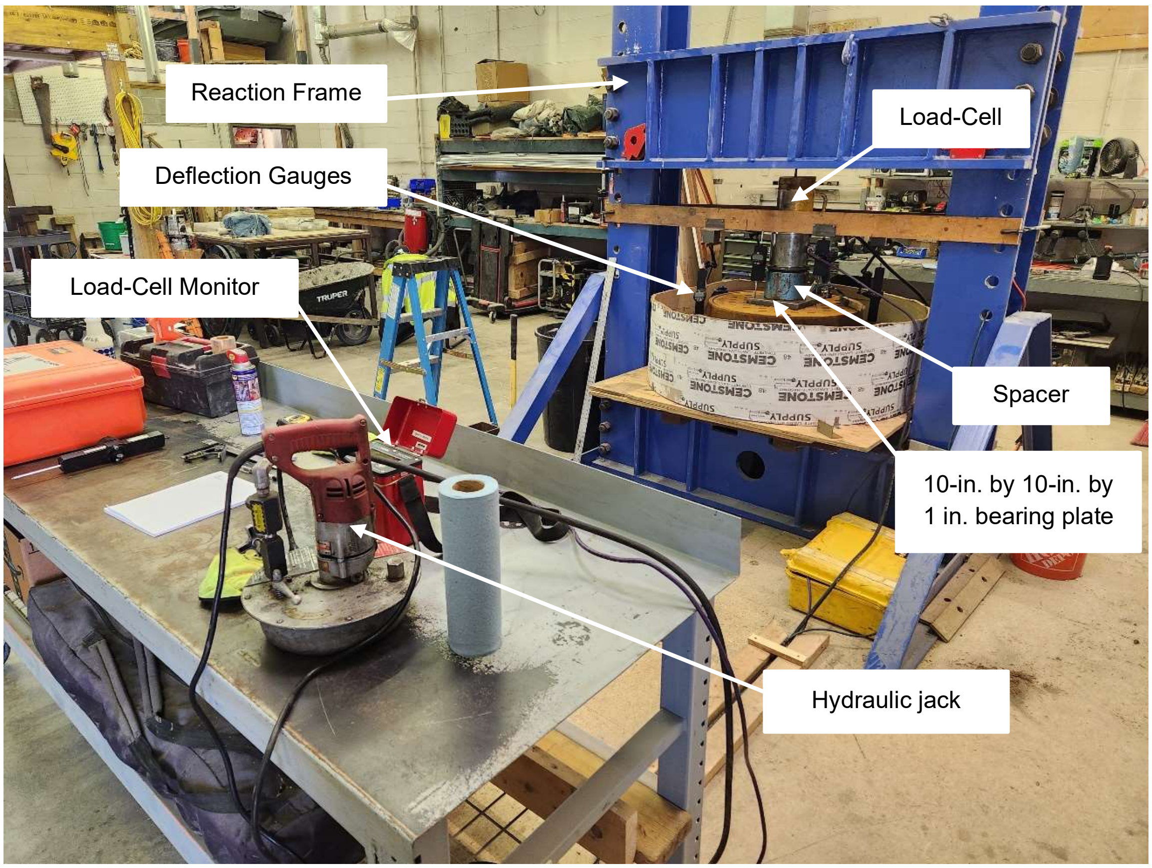

Figure 2.4: Riser ring assembly surrounded by load frame, bearing plate, load cell, spacer, deflection gauges, load-cell monitor, and hydraulic jack

Two deflection gages were placed on top of the cast-iron frame flange that covered the HDPE risers and measured deflection in the risers. The deflection gages were referenced as north and south due to testing orientation. North indicates the gages closest to the load-cell monitor and hydraulic jack. South indicates the gages on the opposite side of the assembly.

Figures 2.5 and 2.6 show the deflection gauge contact with the manhole assembly lip at the north and south side, respectively.

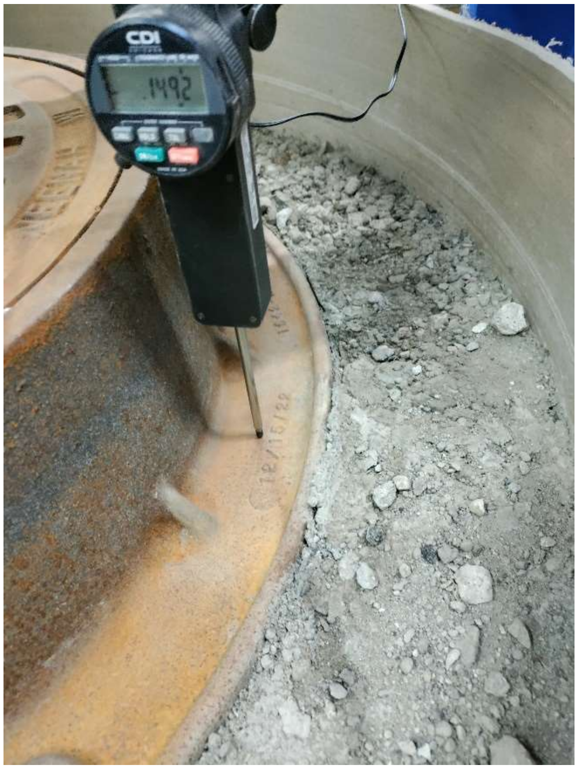

Figure 2.5: Deflection gauge contact – North

Figure 2.6: Deflection gauge contact – South

AET placed an initial load of 1,000 lbs. on the riser ring assembly to seat the load-cell. The load was removed, and the deflection gages were zeroed. Loading was applied to the riser ring assembly by the hydraulic jack in 5,000 lb. increments up to 40,000 lbs. As each 5,000 lb. load increment was applied, the deflections measured by the gages were recorded, and the assembly and load was allowed 5 minutes to equilibrate. After this waiting period, deflections were recorded again. A final deflection reading was recorded when the 40,000 lb. load had been applied for 5 minutes. The load was removed, and the Class 5 aggregate was excavated so AET could observe the riser rings for damage or permanent deformation.

AET continuously recorded the north and south views with video during the load test.

3.0 RESULTS

Table 3.1 displays the deflection values that were recorded at each load step immediately after load was applied or increased and again after the 5 min. waiting period. Note that all deflection sensors measured a deflection increase during the 5 min. pause. Blue circles represent the north deflection sensors and red triangles represent the south deflection sensors. The hollow shapes indicate the initial deflection readings at each load step, while the solid shapes are the final deflection readings after the five-minute period to equilibrate.

During loading it was noted that the North and South deflection sensors were similarly deflecting up to approximately 30,000 lbs. of applied load. Beyond 30,000 lbs. the North deflection sensor remained stuck at the readout. To capture the expected deflection on the risers' north side, the data from 5,000 lbs. up to 30,000 lbs. was used to create a linear regression line and project the expected deflection up to 40,000 lbs. The blue highlighted and italicized data in Table 3.1 corresponds to the data adjusted to the regression line equation.

The average measured deflection of the riser ring assembly at 40,000 lbs. was 0.226 in., which is slightly less than 1/4 in.

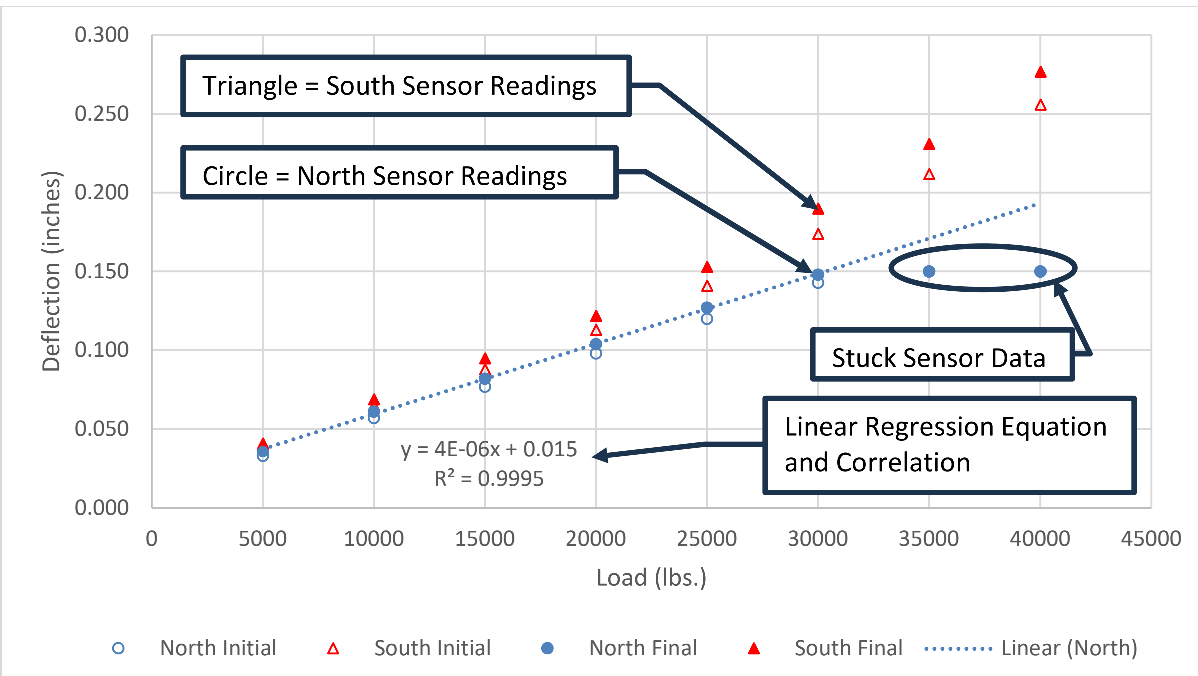

Figure 3.1: Plot of deflection sensor measurements as load increases. The North deflection gauge locked at 30,000 lbs. so regression was used to project deflection at 40,000 lbs.

Table 3.1: HDPE riser deflection with an increase in applied vertical load

		Measured Deflection (inches)		
Load Applied (lbs)	**Hold Time (min)**	**North**	**South**	
5000	0	0.033	0.039	
5000	5	0.036	0.041	
10000	0	0.057	0.065	
10000	5	0.061	0.069	
15000	0	0.077	0.088	
15000	5	0.082	0.095	
20000	0	0.098	0.113	
20000	5	0.104	0.122	
25000	0	0.120	0.141	
25000	5	0.127	0.153	
30000	0	0.143	0.174	
30000	5	0.148	0.190	
35000	0	~~0.150~~	0.212	
35000	5	~~0.150~~	0.231	***0.155***
40000	0	~~0.150~~	0.256	
40000	5	~~0.150~~	**0.277**	***0.175***

North deflection data revised per linear regression set to data points from 5,000 to 30,000 lbs.

North deflection gauge stuck at 35,000 lbs. and 40,000 lbs. Data readings not used.

Average Total Deflection (in.)	~~0.214~~	***0.226***

Average Total Deflection revised for linear regression data points.

4.0 CONCLUSION

AET load tested a HDPE riser and cast-iron manhole frame assembly. AET applied a 40,000 lb. vertical load to the Class 5 aggregate-confined assembly in increments of 5,000 lbs. and the assembly's deflection was measured. The average maximum deflection directly over the HDPE risers at the proof loading of 40,000 lb. was less than ¼-inch.

The loading requirements were taken from the AASHTO published bridge design criteria known as H-20 or HS-20. The prescribed loading aims to replicate a maximum truck axle load of 32,000 lb. or 16,000 lb. wheel load with a 2.5 safety factor. The AASHTO M-306 standard calls for a safety factor of 2.5 to be applied to the 16,000 lb. wheel load. Therefore, the loading applied for traffic rated components must be proof loaded up to the 40,000 lb. maximum loading which was used in this testing.

Following the static load test, the assembly was taken apart and the individual riser rings were inspected for signs of deformation or permanent deformation. AET did not observe any permanent deformation on the risers. There were no observed cracks or breaks in the soil.

AET conducted similar load tests for LadTech in 1999 and 2010 including static load testing of several diameter riser assemblies, a cyclic load test, and load tests in high and low temperature environments. This load test is the first completed where the risers were in a confined environment. The confined environment was compacted base material, which is the condition under which the risers perform in the field except when the road material is greater than 7-inches thick, which is the height of the cast-iron manhole frame.