LADTECH System™

HDPE Manhole Adjusting Rings

Product Description
Warranty
Features and Benefits
Drawings & Dimensions
Test Data
Specify Ladtech
Installation Guide

902 Barton Ave. NW
Buffalo, MN 55313
adjring@ladtech.com
www.ladtech.com
Toll Free: (877) 235-7464
Toll Free Fax (866) 397-7571

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WARRANTY
RETURN POLICY

30 Year WARRANTY & Return Policy

This Certifies that

Ladtech, Inc. proudly offers a '30 year warranty' on the original installation of your Recycled HDPE manhole adjustment rings. The Ladtech SystemTM when properly installed is designed to meet and exceed the applicable loading and chemical resistance performance, as identified in the product specifications and test reports, for a 75 to 100 year design life cycle.

Ladtech Inc. adjustment rings are warranted to be free of manufacturers defects that will impact the performance for a period of 30 years from the date of purchase. This warranty covers the Ladtech SystemTM HDPE Manhole Adjustment Rings. Distributors of the Ladtech SystemTM are authorized to replace any ring which is damaged in any way due to material defect, or handling by the manufacturer or distributor. SIMPLY return the rings to your distributor for new rings. This warranty will not cover installation, consequential damage or freight. Ladtech, Inc. ADJ RINGS meets or exceeds material specifications of AASHTO M306 HS-25, ASTM C-4976, and ASTM C-990. This warranty gives you specific rights, and you may not have other rights which may vary from state to state.

CLAUSE: If for any reason you return adjustment rings to the manufacturer and the rings are not under manufactures defect or under replacement warranty you must obtain prior approval and a restocking fee will be required.

Lana Wiedrich
CEO
Ladtech, Inc.

October 27, 2020

OBJECT: Buy America certification

To Whom It May Concern:

This letter certifies that the products sold by LADTECH, Inc., and supplied to companies in the USA meets the "Buy America" provisions per section 01015—specific project requirements, subsection 16.

Ladtech ® HDPE manhole riser rings are manufactured in the USA out of Sparta, Wisconsin, utilizing 100% recycled waste plastic products also acquired in the USA. When properly installed, the HDPE Adjusting Ring will outperform and outlast its concrete counterpart. Extensive testing and field performance of our product allows us to offer an unprecedented warranty.

Ladtech ® HDPE Adjusting Rings are manufactured according to a specified quality control program that is in compliance with the test results that were acquired by American Testing and Engineering of St. Paul, MN. Also, Ladtech ® HDPE Adjusting Rings has an ASTM – 4976 standards and meets or exceeds AASHTO HS-25 highway loading.

If there are any questions or concerns regarding the manufacturing of the Ladtech adjusting rings, please notify our corporate office.

Sincerely,

Lana Wiedrich
CEO
Ladtech, Inc.
877-235-7464
adjring@ladtech.com

WHY LADTECH??

Imagine a new product designed to replace an existing product where the new one is more economical, easier to use, functions better, requires less maintenance work and to top it all off, is made from recycled waste material. Sound too good to be true? This describes the new injection molded high-density polyethylene (HDPE) manhole adjustment rings manufactured by LADTECH, Inc.

There are several reasons why contractors and municipalities are utilizing the LADTECH HDPE Adjustment rings rather than the concrete adjustment rings. A two-inch thick LADTECH ring weights approximately six pounds as opposed to an eighty-five-pound comparable concrete ring. This weight reduction makes the LADTECH ring easier and safer to handle, thereby reducing the possibilities for on-the-job injuries. The LADTECH adjustment ring eliminates the need for expensive lifting equipment, reduces the time it takes to transport the rings to the job site and set in place and even *exceeds* the performance of its concrete counterpart. The LADTECH HDPE ring is designed and has been tested to withstand the wheel-loading requirement of AASHTO HS25 and will not deteriorate or degrade when exposed to the harsh hydrogen-sulfide environment found in most sewer systems. All things considered, the LADTECH rings are more cost effective to install than traditional concrete adjustment rings. The following confirms an overall installation cost savings.

- The time and expense associated with handling and storage of the heavy concrete rings is eliminated.

- The product loss from breakage of the concrete rings in shipping, storage, and in delivery to the job site is eliminated.

- The LADTECH rings maintain a watertight seal, controlling the infiltration of ground water that adds to the wastewater treatment volumes. This savings can be substantial when combined with the elimination of water infiltration through broken, cracked, and deteriorating rings.

- Costly rehabilitation projects necessary to replace cracked leaking rings are eliminated with the use of LADTECH rings instead of concrete.

FEATURES AND BENEFITS

THE "LADTECH SYSTEM"
HDPE ADJUSTING RINGS
FEATURES AND BENEFITS

Manufactured from High Density Polyethylene (100% Recycled) Plastic

- Light-weight, strong, durable
- Does not contribute to ground pollution
- Inert-will not promote/support mold growth
- Recyclable if unusable
- Help with recycling efforts
- Reduces solid waste

Light Weight

- Easy to lift and place
- Easy to transport/deliver/store
- Reduced shipping costs
- Reduced On-Job injuries
- No heavy equipment required
- Less fatigue/higher production
- Faster job completion
- Less installation cost

High Load Capacity / Impact Resistant

- Exceeds ASSHTO HS 25 Specs
- Absorbs repeated tire impact vibration, slowing deterioration of concrete structure
- Long service life
- Lower actual life-cycle cost
- Better performance in application

Interlocking Design

- Self-Aligning & Stackable
- Easy to store, transport & install
- Aid / Guide for sealant
- Prevents infiltration & inflow

Non-Corrosive

- Will not deteriorate from exposure to sewer gases, road salts or chemicals
- No contribution to ground pollution
- Lower actual life-cycle cost

Varied Sizes / Slope Ring Available

- Several manhole sizes
- Ring heights available allow matching grade within ¼"
- Two or more rings can be stacked and indexed to match any grade angle
- No mortar required to make up odd height or to match grade angle
- System maintains integrity in uniform transfers of load
- No point loading to compromise strength of assembly

Mortarless Assembly

- No mortar to mix and dispose of – or deteriorate causing leakage
- Easier and less costly to assemble – assures quality
- Less equipment needed to assemble
- Less chance for assembly failure and rework

UV & Heat Resistant / Cold Temperature Performance

- Durability around hot asphalt products
- Lower actual life-cycle cost
- Material will not deform under load when cooled
- Stores outdoors for a reasonable period with no UV deterioration
- Longer product life

Specifiable and Inspectable

- Product can be identified and specified by name, material, performance
- Allows specifying engineer a way to control assembly and installation
- A control factor can be applied to the weakest area of an assembly
- Specific installation procedures assure a quality assembly

Cost Effective

- Actual installed cost is an advantage over a concrete ring and mortar
- Saves City / County / State life-cycle cost
- Contractor saves on installation cost
- No additional cost for rehabilitation work

Guarantee / Warranty

- Quality Control with material & manufacturing assures performance
- Ladtech confidence with un-precedented warranty
- Broken rings are replaced at no cost
- Extra rings are reusable on other jobs
- Contractor does not have to back product
- Sales tool for the contractor and specifying engineer

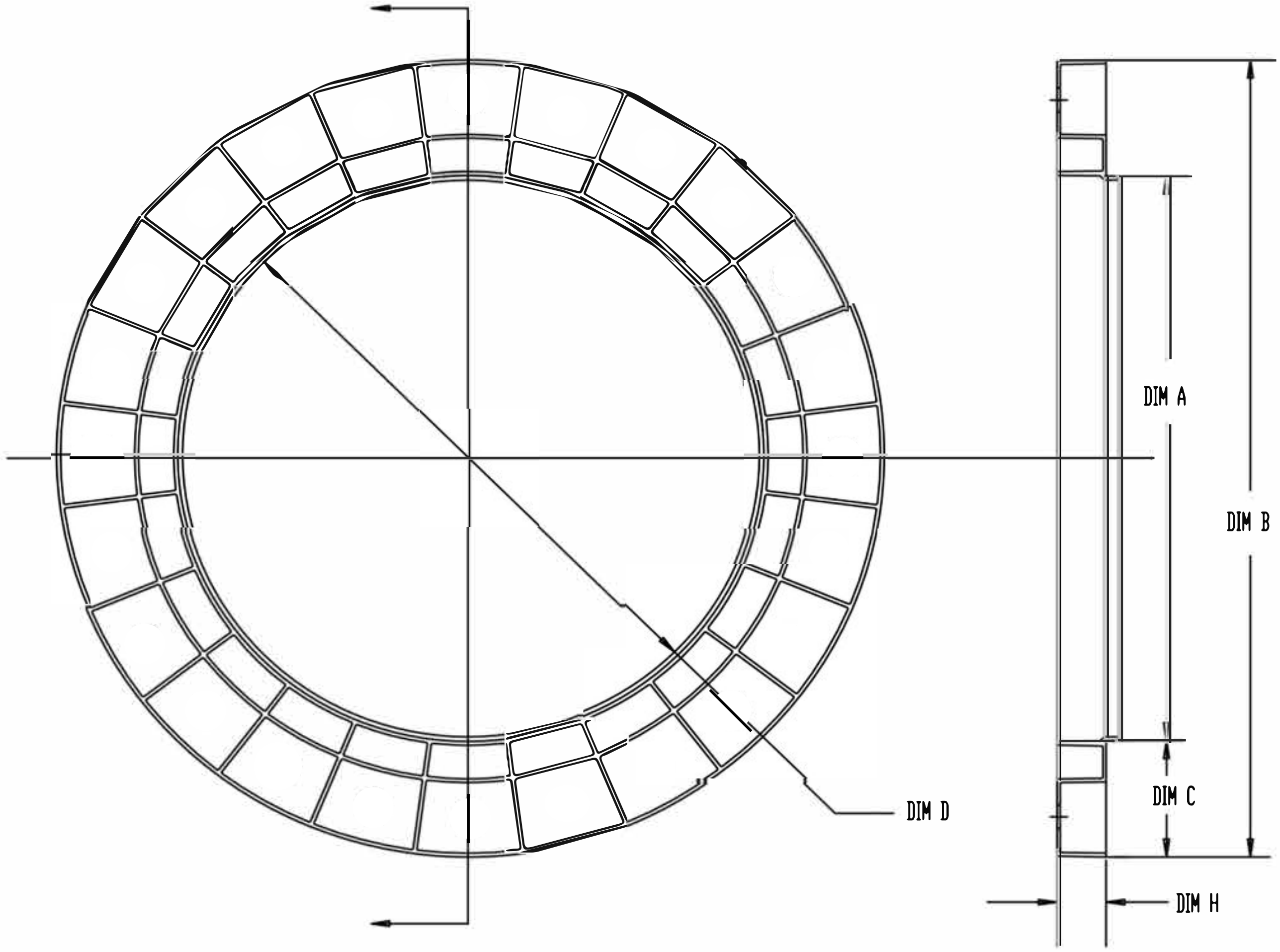
LADTECH System
HDPE MANHOLE ADJUSTING RINGS

DRAWINGS & DIMENSIONS

Round Flat Design
Round Slope Design

24"X24" Catch Basin Flat Design
24"X24" Catch Basin Slope Design

24"X36" Catch Basin Slope Design
24"X36" Catch Basin Flat Design



DESCRIPTION

PLASTIC INJECTION MOLDED ADJUSTMENT RING

MOLDED FROM HIGH DENSITY POLYETHYLENE AS DEFINED IN ASTM SPECIFICATION D-4976

ACTUAL RESIN PROPERTIES WILL VARY ALLOWING FOR THE UTILIZATION OF A MAXIMUM PERCENT OF RECYCLED MATERIAL

THE PERCENT OF POST CONSUMER WASTE TO INDUSTRIAL WASTE WILL VARY WITH AVAILABILITY AND PROPERTY RETENTION NEEDS

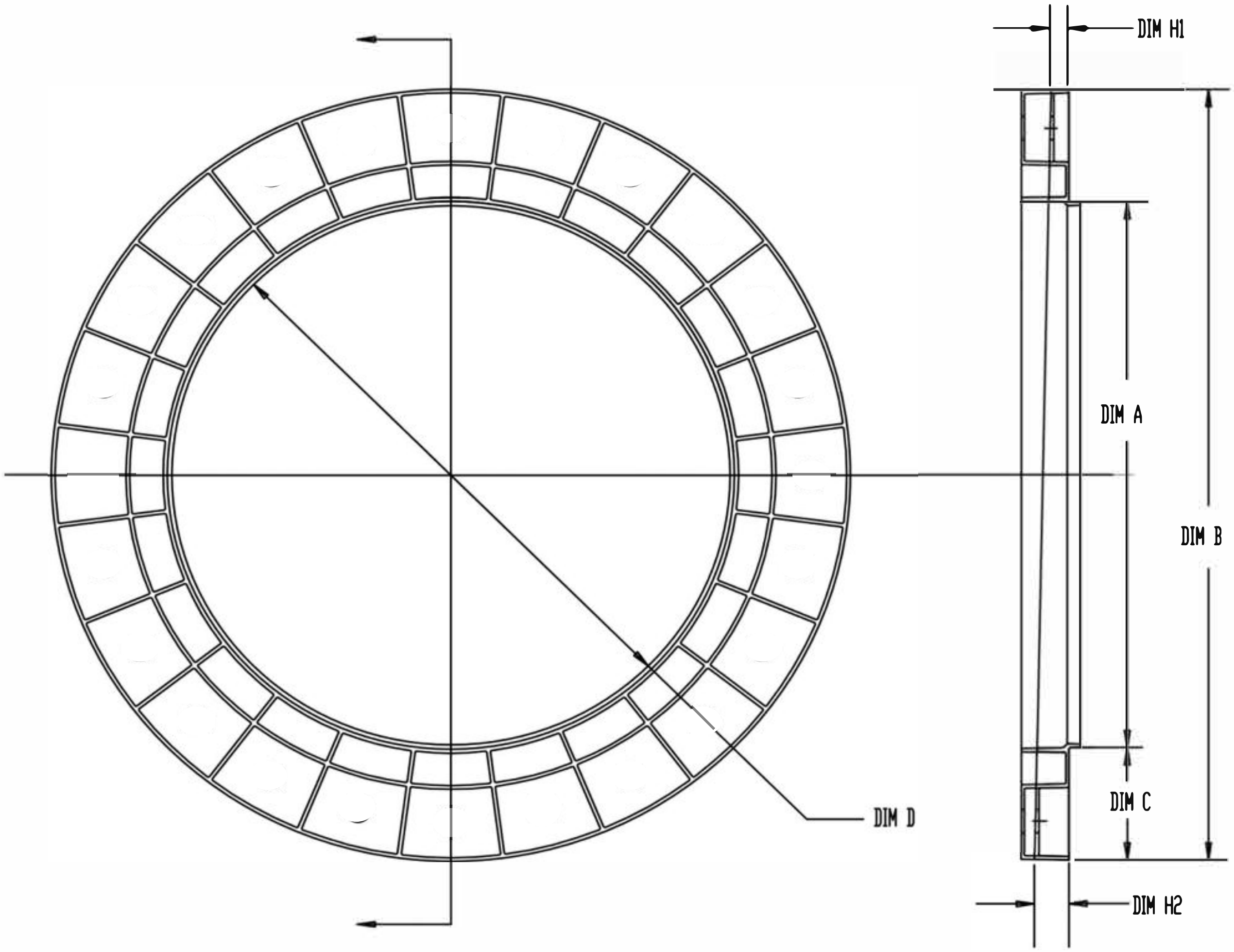
COLOR, SHADE AND UNIFORMITY WILL VARY WITH THE MIX OF THE POST CONSUMER AND INDUSTRIAL WASTE MATERIALS

DIMENSIONS SHOWN ARE NOMINAL - ACTUAL SIZE WILL VARY WITHIN ALLOWABLE TOLERANCE AND REQUIRED FIT

DIMENSION SCHEDULE

CONE SIZE	DIM A	DIM B	DIM C	DIM D	DIM H
24	23.75	33.50	5.00	23.25	1.25, 1.50, 2.00, 4.00
27	26.75	36.50	5.00	26.25	1.25, 1.50, 2.00, 4.00
30	29.75	39.50	5.00	29.25	1.50, 2.00, 3.25
32	31.75	41.50	5.00	31.25	2.00, 3.00
34	33.75	41.50	4.00	33.25	2.00, 3.00 0.25
36	35.75	47.50	5.50	36.25	1.25 2.25 3.00 0.25

APPROVAL DATE______________________ BY__________________________________	DESCRIPTION POLYETHYLENE MANHOLE ADJUSTMENT RING FLAT DESIGN	SPECIFICATION REFERENCE	STANDARD PLATE NO.



DESCRIPTION

PLASTIC INJECTION MOLDED ADJUSTMENT RING

MOLDED FROM HIGH DENSITY POLYETHYLENE AS DEFINED IN ASTM SPECIFICATION D-4976

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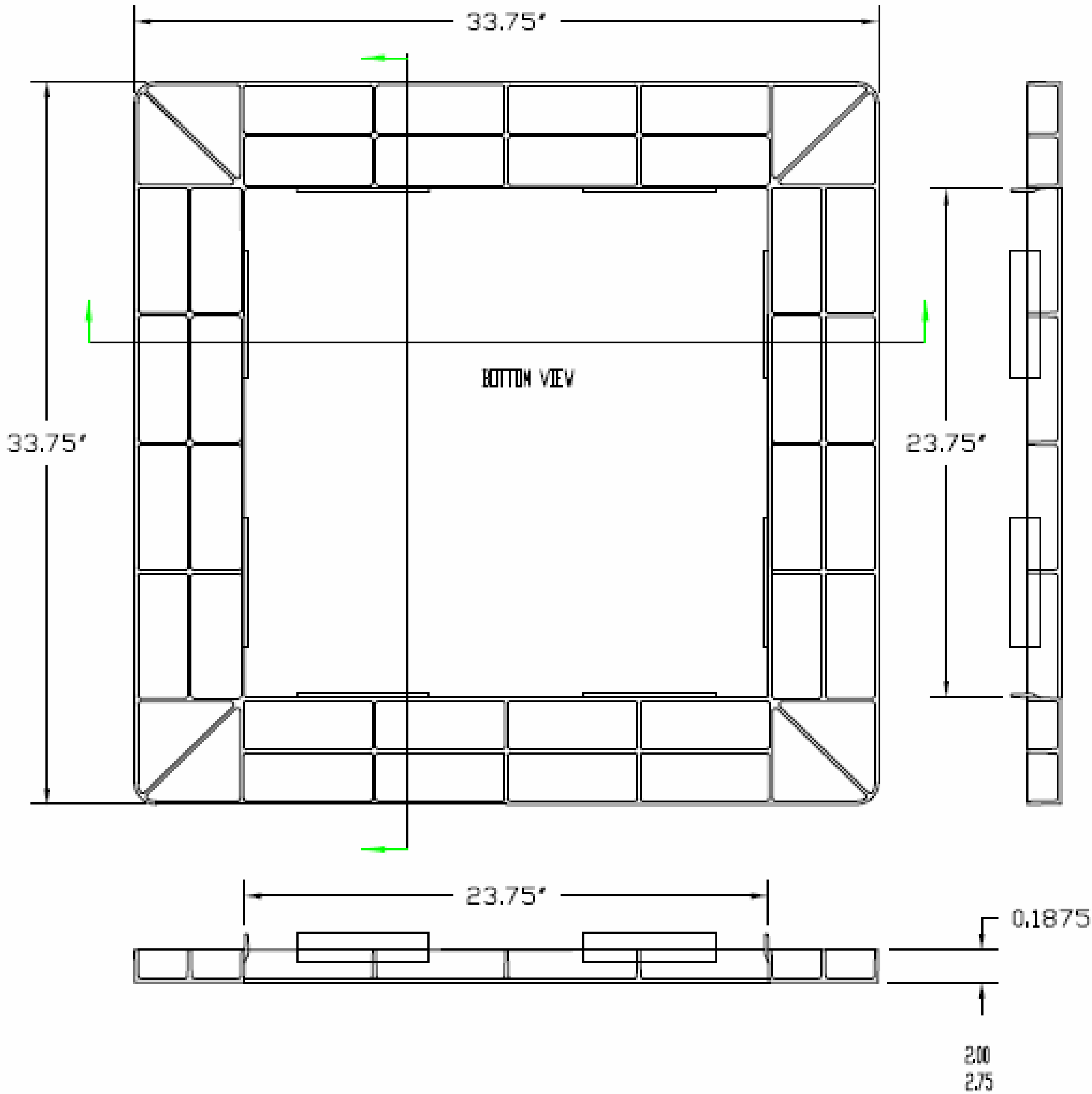
DIMENSIONS SHOWN ARE NOMINAL - ACTUAL SIZE WILL VARY WITHIN ALLOWABLE TOLERANCE AND REQUIRED FIT

DIMENSION SCHEDULE

CONE SIZE	DIM A	DIM B	DIM C	DIM D	DIM H1	- H2
24	23.75	33.50	5.00	23.25	.75	1.50
27	26.75	36.50	5.00	26.25	.75	1.50
30	29.75	39.50	5.00	29.25	1.50	2.25
32	31.75	41.50	5.00	31.25	1.25	2.25
34	33.75	41.50	4.00	33.25	1.25	2.25
36	36.75	47.50	5.50	36.25	1.50	2.50

APPROVAL DATE____________________ BY______________________________	DESCRIPTION POLYETHYLENE MANHOLE ADJUSTMENT RING SLOPE DESIGN	SPECIFICATION REFERENCE	STANDARD PLATE NO.



NOTES:

SLEEVE SHALL BE MOLDED FROM HIGH DENSITY POLYETHYLENE MATERIAL AS DEFINED IN ASTM DESIGNATION D-1248

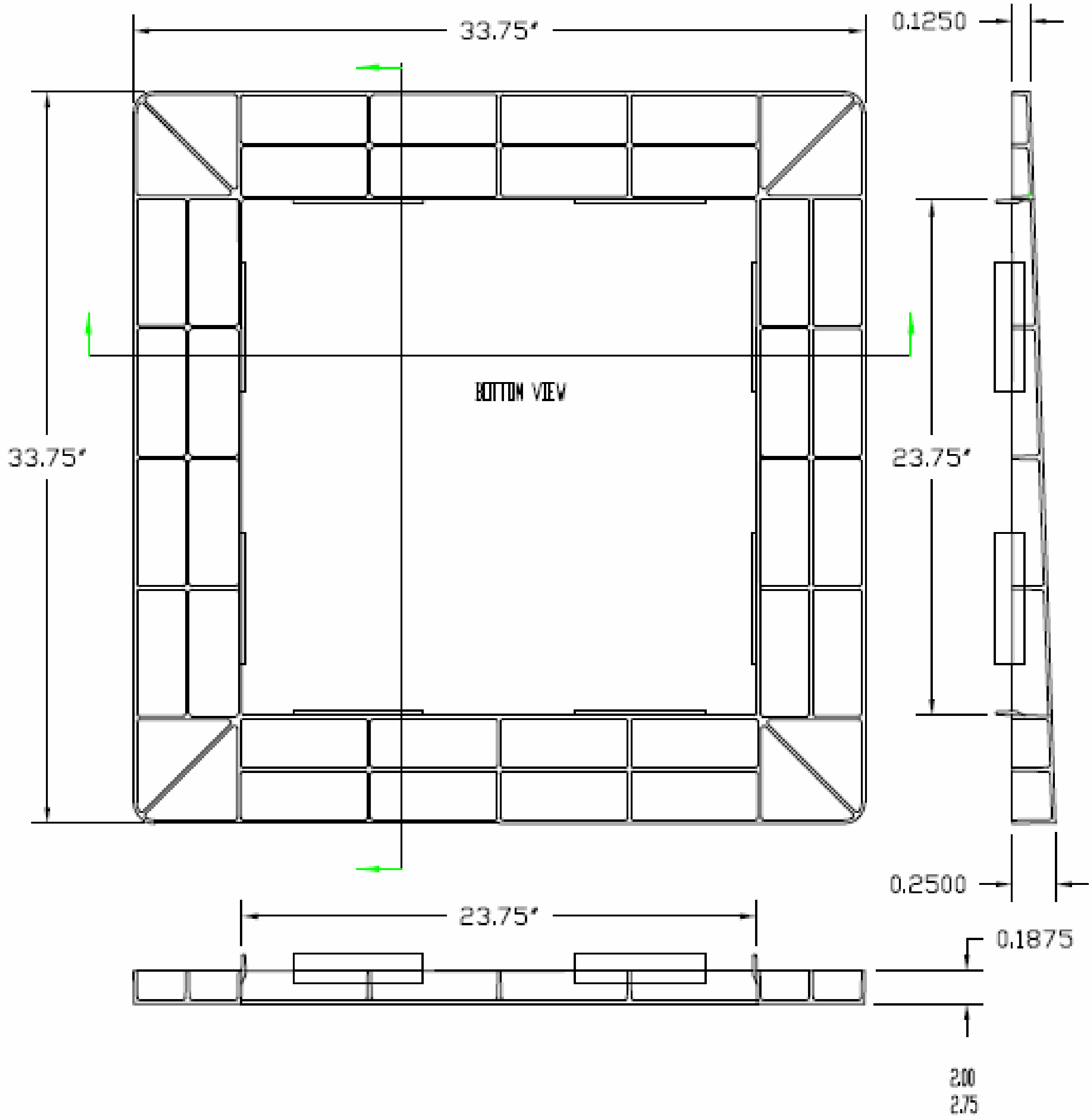
ACTUAL RESIN PROPERTIES WILL VARY ALLOWING FOR THE UTILIZATION OF 100% RECYCLED MATERIAL

THE RATIO OF POST-CONSUMER RECLAIM TO INDUSTRIAL RECLAIM MATERIAL WILL VARY WITH AVAILABILITY AND PROPERTY RETENTION REQUIREMENTS

COLOR, SHADE AND UNIFORMITY WILL VARY WITH THE MIX OF POST-CONSUMER TO INDUSTRIAL RECLAIM MATERIAL

DIMENSIONS GIVEN ARE NOMINAL - ACTUAL SIZE WILL VARY WITHIN ALLOWABLE TOLERANCES AND FIT REQUIREMENTS

APPROVAL DATE________________ BY______________________________	DESCRIPTION INJECTION MOLDED POLYETHYLENE PLASTIC CATCH BASIN ADJUSTMENT SLEEVE FOR 24" BY 24" OPENING FLAT DESIGN	SPECIFICATION REFERENCE	STANDARD PLATE NO.



NOTES:

SLEEVE SHALL BE MOLDED FROM HIGH DENSITY POLYETHYLENE MATERIAL AS DEFINED IN ASTM DESIGNATION D-1248

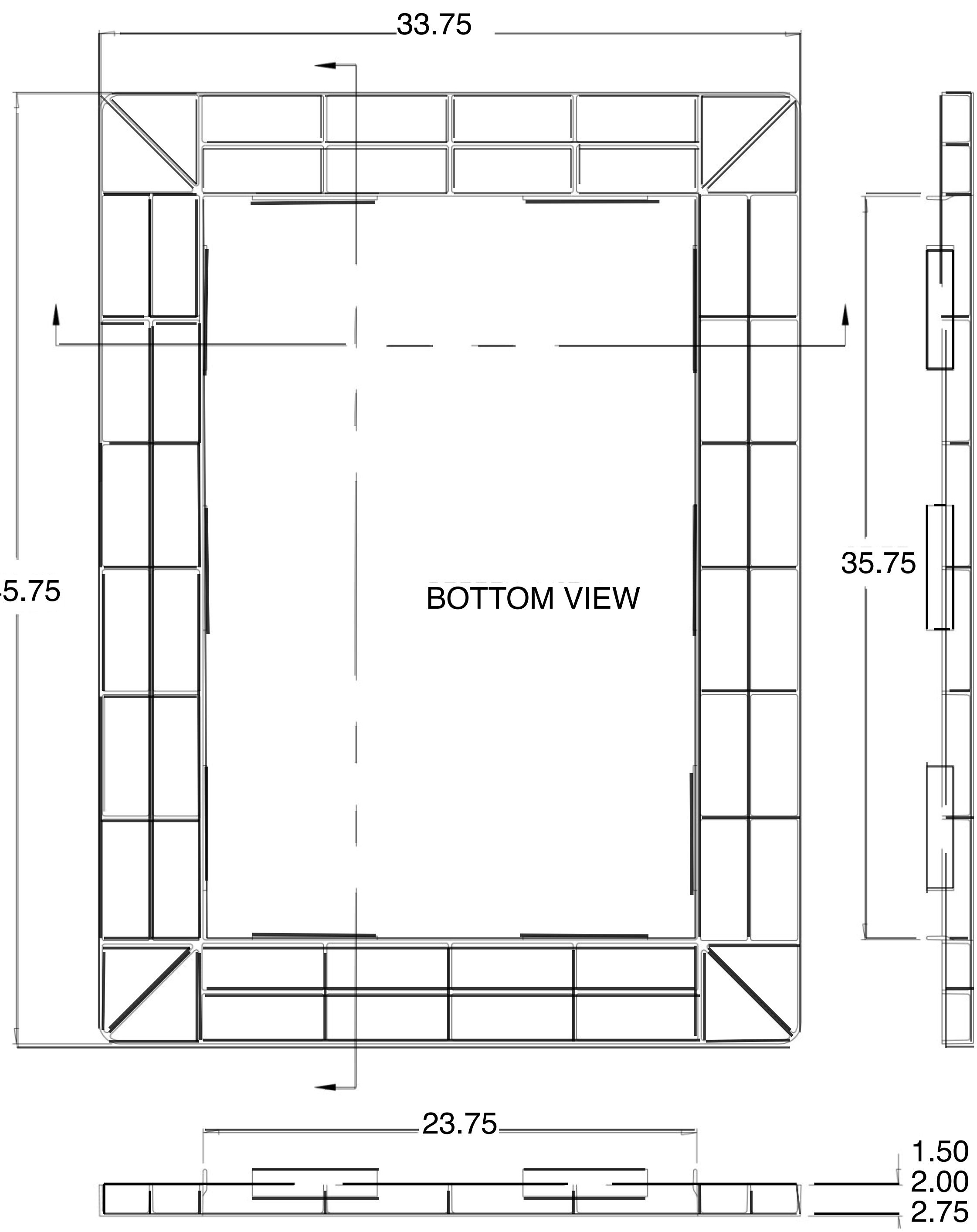
ACTUAL RESIN PROPERTIES WILL VARY ALLOWING FOR THE UTILIZATION OF 100% RECYCLED MATERIAL

THE RATIO OF POST-CONSUMER RECLAIM TO INDUSTRIAL RECLAIM MATERIAL WILL VARY WITH AVAILABILITY AND PROPERTY RETENTION REQUIREMENTS

COLOR, SHADE AND UNIFORMITY WILL VARY WITH THE MIX OF POST-CONSUMER TO INDUSTRIAL RECLAIM MATERIAL

DIMENSIONS GIVEN ARE NOMINAL - ACTUAL SIZE WILL VARY WITHIN ALLOWABLE TOLERANCES AND FIT REQUIREMENTS

APPROVAL DATE__________ BY__________	DESCRIPTION INJECTION MOLDED POLYETHYLENE PLASTIC CATCH BASIN ADJUSTMENT SLEEVE FOR 24" BY 24" OPENING SLOPED DESIGN (1% GRADE)	SPECIFICATION REFERENCE	STANDARD PLATE NO.

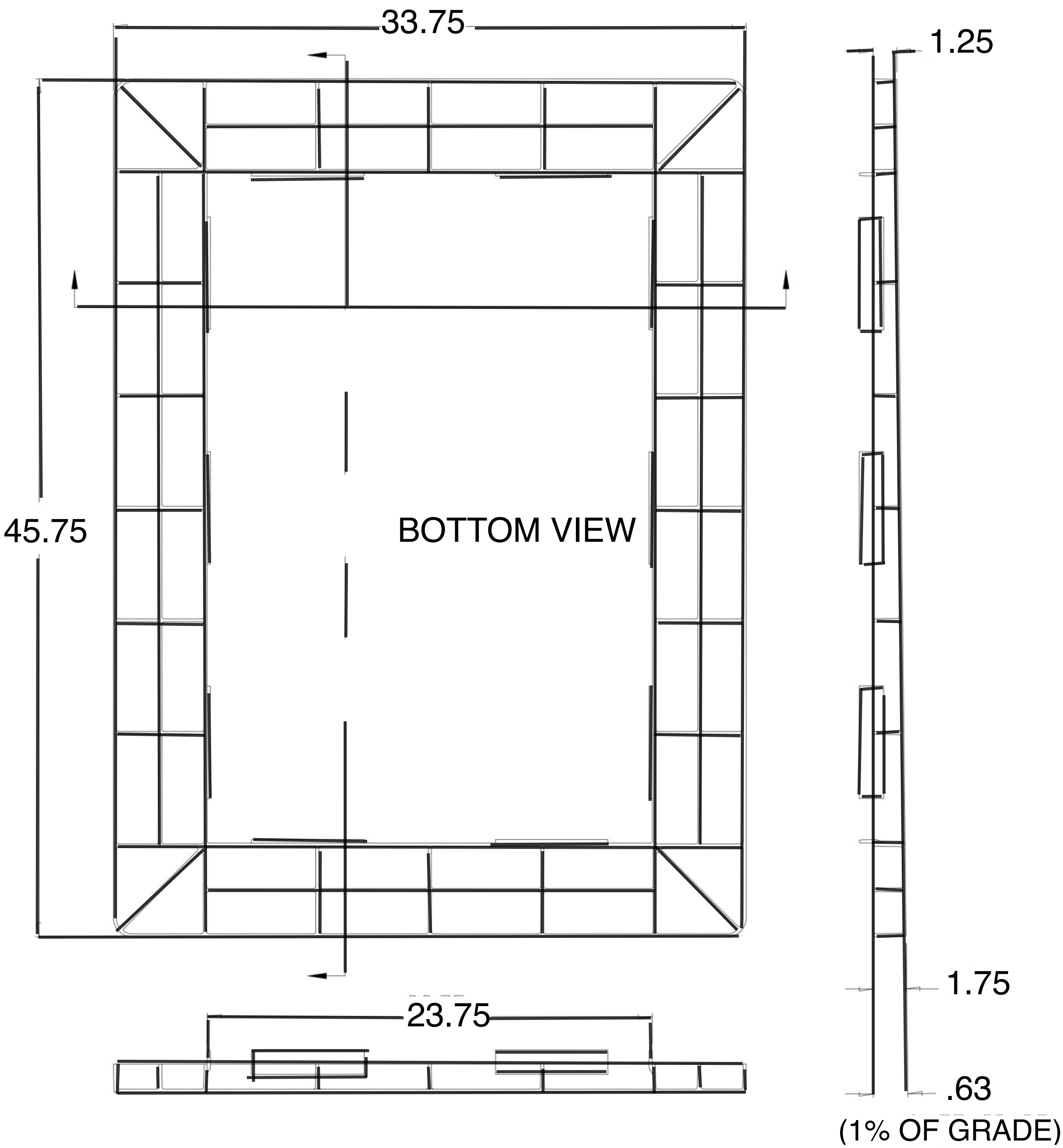


NOTES:

SLEEVE SHALL BE MOLDED FROM HIGH DENSITY POLYETHYLENE MATERIAL AS DEFINED IN ASTM DESIGNATION D-4976 ACTUAL RESIN PROPERTIES WILL VARY ALLOWING FOR THE UTILIZATION OF 100% RECYCLED MATERIAL. THE RATIO OF POST - CONSUMER RECLAIM TO INDUSTRIAL RECLAIM MATERIAL WILL VARY WITH AVAILABILITY AND PROPERTY RETENTION REQUIREMENTS.

COLOR, SHADE AND UNIFORMITY WILL VARY WITH THE MIX OF POST - CONSUMER TO. INDUSTRIAL RECLAIM MATERIAL DIMENSIONS GIVEN ARE NOMINAL - ACTUAL SIZE WILL VARY WITHIN ALLOWABLE TOLERANCE AND FIT REQUIREMENTS.

APPROVAL DATE	DESCRIPTION	SPECIFICATION REFERENCE	STANDARD PLATE NO.
BY:	INJECTION MOLDED POLYETHYLENE PLASTIC CATCH BASIN ADJUSTMENT SLEEVE FOR 24” BY 36” OPEING FLAT DESIGN		



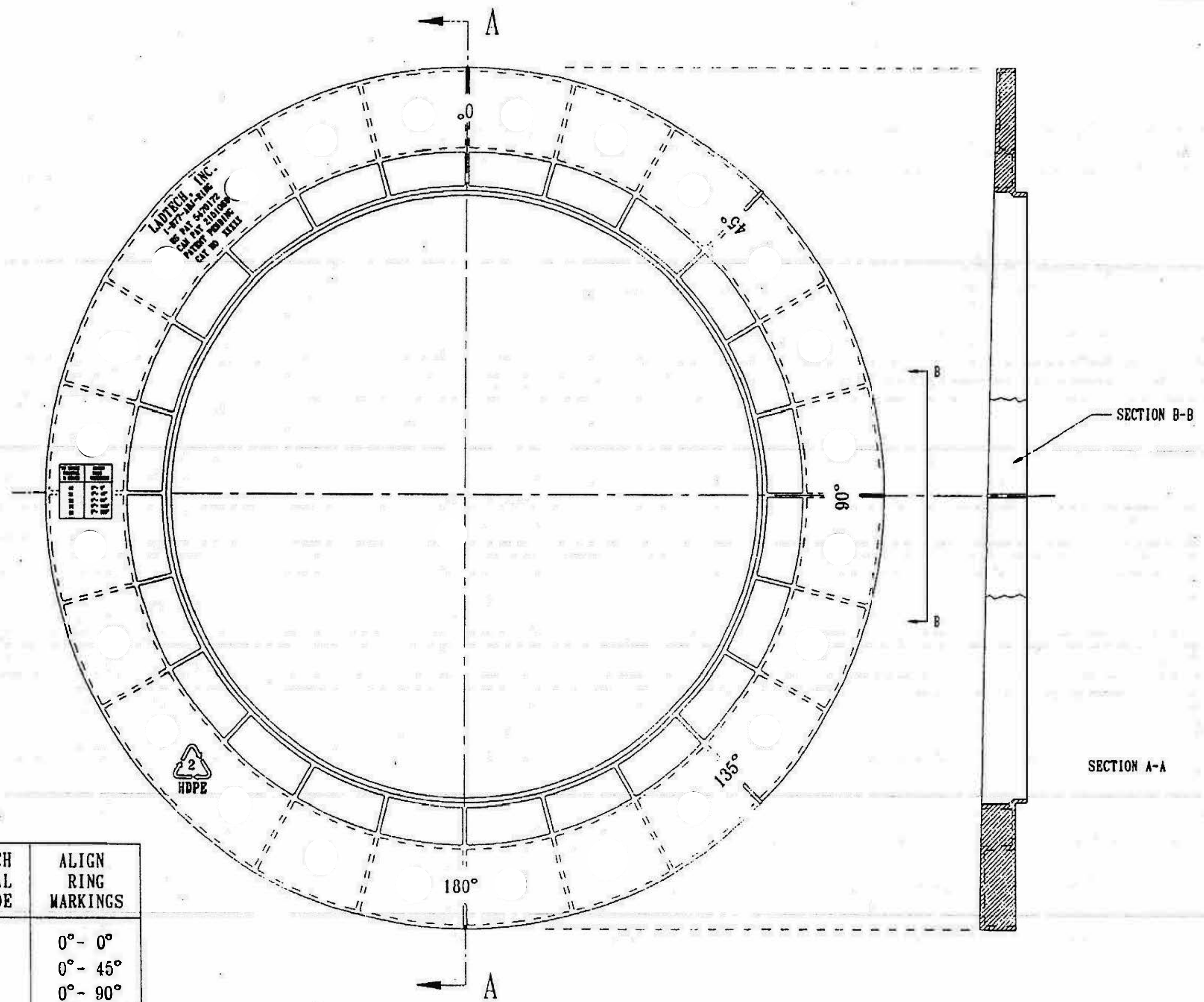
NOTES:

SLEEVE SHALL BE MOLDED FROM HIGH DENSITY POLYETHYLENE MATERIAL AS DEFINED IN ASTM DESIGNATION D-4976 ACTUAL RESIN PROPERTIES WILL VARY ALLOWING FOR THE UTILIZATION OF 100% RECYCLED MATERIAL. THE RATIO OF POST - CONSUMER RECLAIM TO INDUSTRIAL RECLAIM MATERIAL WILL VARY WITH AVAILABILITY AND PROPERTY RETENTION REQUIREMENTS.

COLOR, SHADE AND UNIFORMITY WILL VARY WITH THE MIX OF POST - CONSUMER TO. INDUSTRIAL RECLAIM MATERIAL DIMENSIONS GIVEN ARE NOMINAL - ACTUAL SIZE WILL VARY WITHIN ALLOWABLE TOLERANCE AND FIT REQUIREMENTS.

APPROVAL DATE________ BY________________	DESCRIPTION INJECTION MOLDED POLYETHYLENE PLASTIC CATCH BASIN ADJUSTMENT SLEEVE FOR 24” BY 36” OPEING SLOPE DESIGN 1% GRADE	SPECIFICATION REFERENCE	STANDARD PLATE NO

REV	DESCRIPTION	DATE	APPROVED
A	NOTED TO C, SLOPE RINGS ADD PATENT NO'S	1/04/99	



TO MATCH NOMINAL % GRADE	ALIGN RING MARKINGS
4%	0°- 0°
3%	0°- 45°
2%	0°- 90°
1%	0°- 135°
0%	0°- 180°

4 X SCALE

THE INFORMATION CONTAINED ON THIS DRAWING IS CONSIDERED PROPRIETARY AND DISCLOSURE TO OTHERS IS PROHIBITED WITHOUT WRITTEN APPROVAL.

DIMENSIONS ARE IN INCHES UNLESS OTHERWISE NOTED

TOLERANCES (EXCEPT AS NOTED)

LADTECH, INC.
244 WOODRIDGE LANE
LINO LAKES, MN 55014 PHONE: 651-415-1252

TITLE ENGRAVING--GRADE INDEX/TABLE

DWG NO. 1094-020 REV A

FILE: 1094-020

Office: (651) 415-1252

Fax: (651) 415·-1252

Toll Free: 1-877-ADJ-RING

MATERIAL SPECIFICATION SHEET

LADTECH® POLYETHYLENE BLEND #9801
POST CONSUMER, MIXED-COLOR, HIGH DENSIY POLYETHYLENE FLAKE

The following data was developed by LADTECH personnel utilizing the plastic laboratory of Hennepin Technical College, Brooklyn Park, MN in June of 1998.

PROPERTY	ASTM	VALUE	UNITS
Melt Index	D 4976	.49	g/I0 min.
Density	*Estimated	. 94 - .96	g/cm^2
Tensile Strength @ yield	D638	3,453	PSI
Elongation @yield	D638	122	%
Flexmal Modulus	D790	147,771	PSI
Izod Impact Strength	D256	7.12	ft-lb/in
Handlness (Shore D)	D2240	63.1	
Heat Deflection Temp.	D648	174°F	@66 PSI
Shrinkage	D955	.032	in/in

The above data is representative of LADTECH primary-use blend polyethylene. This blend is produced from lOO %, recycled polyethylene. The predominant source product for the raw plastic is curbside collected, post-consumer, blow molded milk jugs, detergent bottles and injection molded thin-wall Containers. The material is shredded, washed, dried and sized to LADTECH specifications.

* Estimated value based on known v8lues of blended raw materials typically used for the specific product

Reissued with changes June 20, 1999

902 Barton Ave. Buffalo, MN 55313 • E-Mail: adjring@ladtech.com www.ladtech.com

TECHNICAL & TEST DATA

AERO MECHANICAL TECHNOLOGIES, INC.
Satisfactory Static & Impact Structural Design Confirmation

AMERICAN ENGINEERING TESTING, INC. Letter of Approval
AMERICAN ENGINEERING TESTING, INC. LETTER
Cycle Load / AASHTO 25 Wheel Load

Static Load Compression

High Temperature/Hot Mix Asphalt Concrete and Compression
Low Temperature

ASTM D-1693-97a ENVIRONMENTAL STRESS CRACKING

AERO/MECHANICAL
TECHNOLOGIES INC.
2195 WEST HWY. 36
ROSEVILLE, MINNESOTA 5511:

28 May 1996

Mr. Dwight Wiedrich
President
LADTECH, INC.
244 Woodridge Lane
Lino Lakes, Mn 55014

Dear Mr. Wiedrich;

This letter is to provide you with confirmation of a satisfactory static and impact structural design of your spacer adjustment rings.

The spacer was theoretically evaluated for its structural integrity on the following points (DOW HDPE High Density Polyethylene 10062N equivalent material was used for analysis data, with an ultimate strength of 4,100 lb/in^2 and yield strength of 3,400 lb/in^2).

A. Static Compressive Von Mises Stress (25,250 lb load fully centered)-
Stress value of about 672 lb/in^2 and safety factor of 6.1 (for an average compressive Modulus of Elasticity of 184,000 lb/in^2) compared with industry standard S.F. of about 3.

B. Static Shear Stress (22% Grade with 25,250 lb load fully centered)-
Stress value of about -376 lb/in^2 and safety factor of 5.4 times was obtained (with respect to a flectural shear maximum stress criteria of 1/2 that of yield- 2,050 lb/in^2).

C. Static Elastic Stability (Buckling) Stress (25,250 lb load centered)-
Critical force to induce buckling onset for a spacer stack of 8 units revealed a safety factor of 25 and that this is not an issue for the spacer.

D. Shock Impact Effects Free Fall of .75 inch @ 25,250 lb load centered)-
Deceleration shock gain of 5.8 g's is estimated with a compresssion of .026 inches and a stress of 3,228 lb/in^2 and a safety factor of 4.2 times (since only 1/4 of load acts on spacer at impact).

A. Static Compressive Von Mises Stress (25,250 lb load offset)-
Stress value of about 1432 lb/in^2 and safety factor of 2.9 (for an average compressive Module of Elasticity
of 184,000 lb/in^2) compared with industry standard S.F. of about 3.

B. Static Shear Stress (22% Grade with 25,250 lb load offset)-
Stress value of about -808 lb/in^2 and safety factor of 5.4 times was obtained (with respect to a flectural shear maximum stress criteria of I/2 that of yield- 2,050 lb/in^2*).*

C. Static Elastic Stability (Buckling) Stress (25,250 lb load offset)-
Critical force to induce buckling onset for a spacer stack of 8 units revealed a safety factor of 13 and, consequently, this is not an issue for the spacer.

D. Shock Impact Effects Free Fall of.75 inch ~ 25,250 lb load offset)-
Deceleration shock gain *of 5.8* g's is estimated with a compression of .026 inches and a stress of 3,930 lb/in^2 and a safety factor of 1.0 times (since 1/4 load acts on spacer at impact).

The finite element analysis was conducted with a 1.0 degree tapered draft contribution from the ribbings and from the outer and inner periphery areas.

The analyses was based on a full 360 degree modeled Finite Element analysis design feasibility as the results provide a better, simpler overall understanding of the total force pattern, both for a symmetric and for an offset force loading with the same symmetric boundary conditions such as displacement constraints of the spacer *.

Based on the results of the finite element methods analysis and on the theoretical calculations, it is my opinion that the adjustment spacer design is sufficient for the mentioned forces and impact generated forces. If there are any questions or more information needed, please call the number below.

Very Respectfully,

Noel L. Allen, P.E., Mn Lie 20366 .
Consulting Engineering Services
AEROIMECHANICAL TECHNOLOGIES, INC.
2195 West Hyway 36
Roseville, Mn 55113

..eby certify that this plan
..ification, or report was prepared ..,
..nder my direct supervision and that
..uly Registered Professional Engineer
.. the laws of the State of Minnesota.
Noel L. Allen
8/24/96

*The theoretica1 static loading was simulated in the Finite Element analysis and calculation by distributing the total load of 25,250 LB evenly over the total surface area of the top steel cover for *the* symmetrical casting evenly over a 180 degree hemispherical section of the top cover for the offset case.

AMERICAN
ENGINEERING
TESTING, INC

*GEOTECHNICAL
*MATERIALS
*ENVIRONMENTAL

January 15, 1999

Mr. Gale Jacobsen
LADTECH, Inc.
319 Aster Drive
Northfield, MN 55057

Re: HDPE Adjusting Ring Testing Program
AET Job No. 05-00175

Dear Mr. Jacobsen:

American Engineering Testing, Inc. (AET) has completed the testing program for the high-density polyethylene (HDPE) adjusting ring product manufactured by LADTECH, Inc. The scope of our work included subjecting various combinations of adjusting rings to a series of tests and documenting the results.

The following tests were performed as part of our testing program:

- 1,005,334-cycle load test with simulated AASHTO HS-25 wheel load
- Static compression testing of 6", 10", and 16" high adjusting ring combinations
- Hot-mix asphaltic concrete exposure and compression testing
- Static compression testing of specimens subjected to 5° F. temperatures

The intent of the testing program was to subject the '1djusting rings to load and thermal conditions that may occur in actual field installations.

Summary of Test Results

Overall, the results of our test program indicate the 6", 10" and 16" adjusting ring combinations are capable of supporting an AASHTO HS-25 wheel load. Further, a 2" + 4" ring combination satisfactorily resisted 1,005,334 cycles of a simulated HS-25 'wheel load dropping from a height of 3/4" without· experiencing fatigue cracking or significant permanent deformation.

Exposure of a 2" + 4" adjusting ring combination to asphaltic concrete did not affect the ability of the rings to resist a simulated HS-25 wheel load. The 4" adjusting ring did experience minor peripheral cracking. The cracking did not compromise the water tightness of the system. The 2" adjusting ring did not show any cracking as a result of exposure to the hot asphaltic concrete.

"AN AFFIRMATIVE ACTION EMPLOYER"
550 Cleveland Avenue North· St. Paul, *MN* 55114***. 651-659-9001. Fax 651-659-1379***
Duluth. Mankato· Marshall- Rochester. Wausau

AMERICAN
ENGINEERING
TESTING, INC.

*GEOTECHNICAL
*MATERIALS
*ENVIRONMENTAL

REPORT OF HDPE ADJUSTING RING CYCLICAL TESTING

PROJECT:

HDPE ADJUSTING RINGS
CYCLICAL LOAD TESTING

REPORTED TO:

LADTECH, INC.
244 WOODRIDGE LANE
LINO LAKES, MN 55014

ATTN: GALE

JACOBSEN

ART JOB NO: 05-00175

DATE: JANUARY 15, 1999

INTRODUCTION

This report presents the results of testing performed on high-density polyethylene (HDPE) adjusting rings used in conjunction with concrete manhole structures. The scope of our work was limited to the following:

- Subject a stack of HDPE rings to 1,000,000 cycles of a simulated AASHTO HS-25 wheel load
- Measure the strain in the rings under load at selected locations and times
- Document the condition of the ring stack following completion of the test
- Prepare a report detailing the results of the testing

Our work was requested and authorized by Mr. Gale Jacobsen of LADTECH, Inc. on September 4, 1998, and performed in general accordance with AET Proposal No. 5-98-039, dated July 13, 1998.

BACKGROUND INFORMATION

The adjusting rings are manufactured from 100% recycled plastic. Per LADTECH, the predominant source product for the raw plastic is curbside collected, post-consumer, blow-molded milk and detergent bottles. The bottles are initially manufactured from high density polyethylene as identified by ASTM Standard D-4976. Following shredding and cleaning of the bottles, the rings are manufactured by injection molding techniques.

TEST PROCEDURES

The cyclic load testing was performed at the University of Minnesota Civil Engineering Structures Lab. The test apparatus consisted of an MTS Model 311 Material Test Frame with 600-kip servo controlled hydraulic actuator. An MTS Model 458 controller was used to control the actuator and generate the signal to continually load and unload the adjusting ring assembly. The load applied to the ring assembly was cycled with the load path following a 1 Hz sine wave.

The strain gages used for the test were Model FLA-3-23-3LT (3mm gage length) from Tokoyo Sokki Kenkyujo Co., Ltd and affixed with a cyanoacrylate adhesive. An additional strain gage was affixed to an unloaded adjusting ring for temperature correction. An OPTIM data acquisition system was used to collect the data. Data was collected at a rate of 50Hz. Readings were taken once or more each day, except on weekends.

The adjusting ring stack used for the test consisted of two (2)- 4" and one (1)- 2" rings with the 2" ring being the uppermost. A 54" diameter x 5" thick concrete manhole slab with a 24 1/4" diameter hole was used as the base of the test assembly. The slab was placed on the strong floor of the lab with the hole centered over the load frame, and was set on a mortar bed. The adjusting ring stack was placed on the slab followed by the manhole frame. A 1/4" bead of butyl caulk was placed between the slab and first ring, between each subsequent ring, and before placement of the manhole frame. The ten strain gages were mounted in various locations on the middle adjusting ring. The manhole cover, which was bolted to the hydraulic actuator, was then lowered in-place.

Once loading began, the adjusting ring assembly was subjected to a 21.3 kip (21,300 pounds) load range to simulate an AASHTO HS-25 wheel load and the impact from a 3/4" grade difference. A daily log was kept and information recorded included date, time, cycle count, maximum and minimum actuator load and stroke values, and any pertinent information.

TEST RESULTS

The cyclic test was run continuously from July 31, 1998 to August 12, 1998, except for brief shutdowns on August 5 and 11. Test data on the behavior of the 10 strain gages was also collected continuously between these dates.

The adjusting rings did not show any visible cracking or significant permanent deformation after being subjected to 1,005,334 cycles of a 21.3 kip (average) load. The strain gage data indicated the rings deformed elastically.

DISCUSSION

The cyclic testing was performed to document the ability of the adjusting rings to resist repeated dynamic loading without failing (e.g., cracking, buckling, etc.). The results show the rings performed satisfactorily in this regard.

The test procedure did not consider the effects of subgrade confinement as will occur in actual field applications. The confining pressure of the soil, base aggregate, or pavement against the rings will reduce overall deformation of the ring stack and resist lateral loads exerted by vehicles moving across the manhole cover. To this end, the load conditions in the laboratory cyclic test were more severe than that would be encountered in actual field installations.

REMARKS

The samples will be retained in our lab for a period of 30 days from the date of this report. Contact us if you would like the samples held longer or returned to you.

To protect the client, the public and American Engineering Testing, Inc., this report (and all supporting information) is provided for the addressee's own use. No representations are made to parties other than the addressee.

Report Prepared by:

Daniel J. Larson, P.E.
Vice President, Materials Division

Reviewed by:

Mark L. Tipler
Engineering Assistant

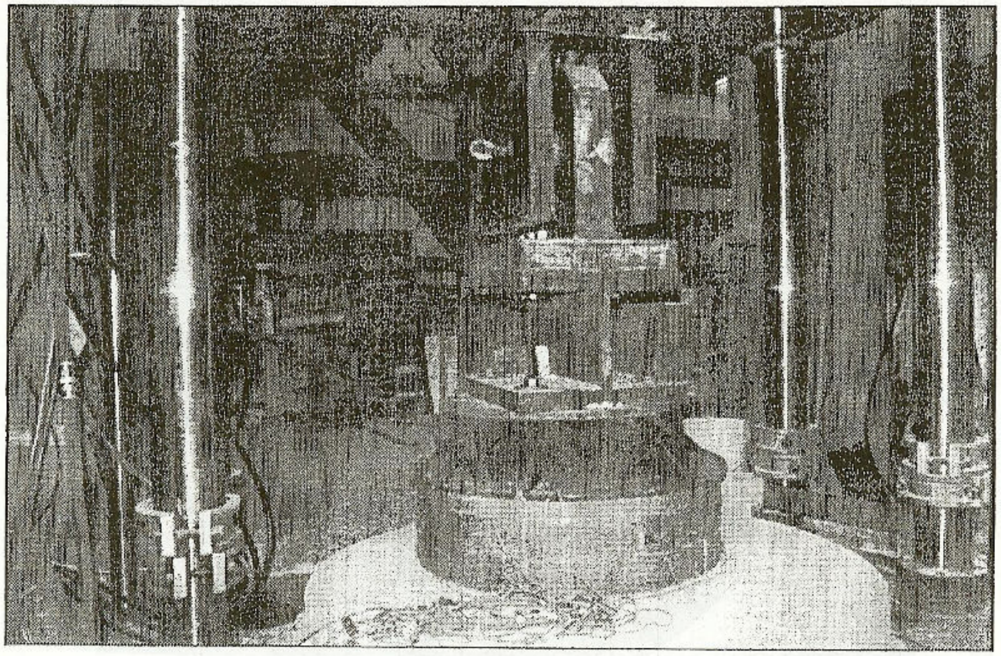
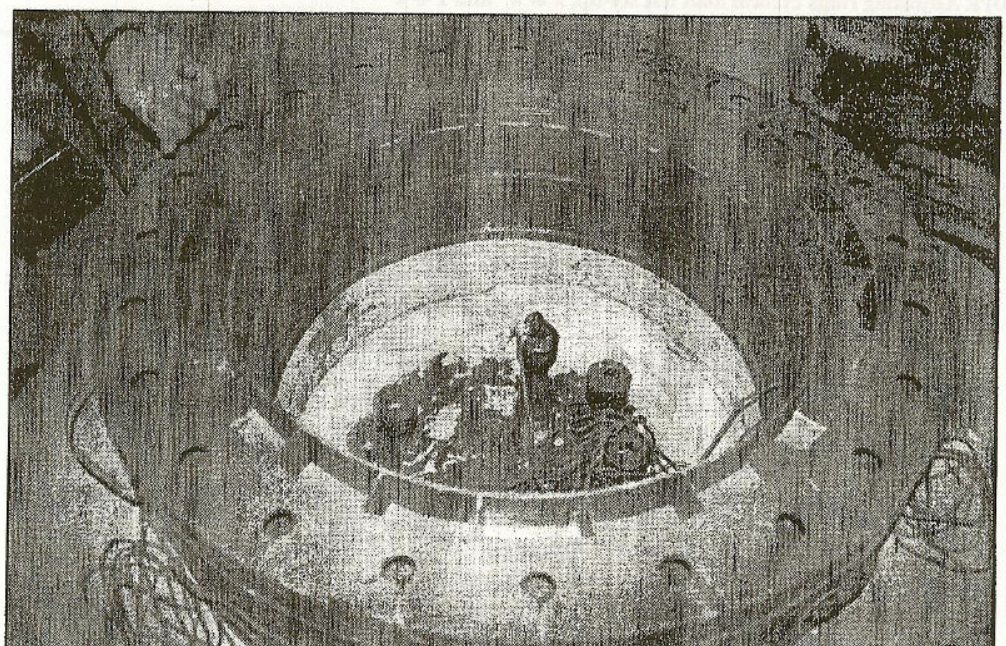


Photo 2: **HDPE Adjusting Rings cyclical load testing in progress**

Photo 3: **Tear down of the HDPE Adjusting rings cyclical load testing**



PHOTOGRAPHS
AET JOB NO. 05-00175

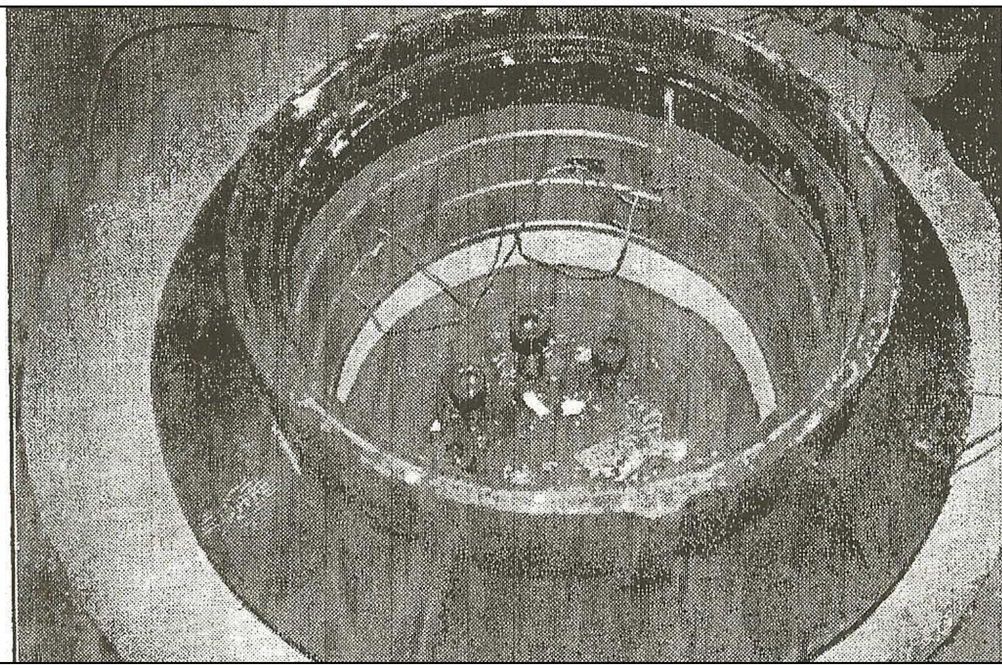


Photo 1: HDPE Adjusting rings cyclical load test set-up, 2 @ 4” and 1 @ 2”

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- MATERIALS
- ENVIRONMENTAL

REPORT OF HDPE ADJUSTING RING STATIC TESTING

PROJECT:

HDPE ADJUSTING RINGS
STATIC LOAD TESTING

AET JOB NO:
05-00175

REPORTED TO:

LADTECH.INC.
244 WOODRIDGE LANE
LINO LAKES, MN 55014

ATTN: GALE JACOBSEN

DATE: JANUARY 15, 1999

INTRODUCTION

This report presents the results of testing performed on high-density polyethylene (HDPE) adjusting rings used in conjunction with concrete manhole structures. The scope of our work was limited to the following:

- Perform static load testing of five (5) sets of adjusting ring stacks
- Measure deflection of the ring stacks under load and observe ring performance
- Prepare a report detailing the results of the testing

Our work was requested and authorized by Mr. Gale Jacobsen of LADTECH, Inc. on September 4, 1998, and performed in general accordance with AET Proposal No. 5-98-039, dated July 13, 1998.

BACKGROUND INFORMATION

The adjusting rings are manufactured from 100% recycled plastic. Per LADTECH, the predominant source product for the raw plastic is curbside collected, post-consumer, blow-molded milk and detergent bottles. The bottles are initially manufactured from high density polyethylene as identified by ASTM Standard D-4976. Following shredding and cleaning of the bottles, the rings are manufactures by injection molding techniques.

.

TEST PROCEDURES

The static load testing was performed in the American Engineering Testing (AET) laboratory. The loading apparatus consisted of a 600,000 pound capacity load frame and 20 ton Ram-Pac hydraulic ram with a Simplex hand pump. The loads were measured with a 100,000 pound capacity Rice Lake RLCSP1 load cell and Virtual VC-505 controller. Deflection measurements were obtained with dial gauges accurate to 0.001".

A 4'x4' x 4%" concrete manhole slab with a 24" diameter hole was used as the base of the test assembly. The slab was centered in the load frame, set on a gypsum mortar bed, and leveled. The adjusting ring stacks were placed directly on the slab followed by the manhole frame and cover.

Five (5) adjusting ring stacks were tested as follows:

Test Number;	. Ring Configuration	Total Stack Height 'n
1	One (1) - 4" and one (1) - 2"	6"
2	Two (2) - 4" and one (1) - 2"	10"
3	Three (3) - 4" and two (2) - 2"	16"
4	One (1) - 4" and one (I) - Slope	
5	One (1) - 4" and two (2) - Slope	

For each ring stack, compressive load was steadily applied in 5,000 Ib increments. The load point was offset from the centerline of the manhole cover for Tests #2 - #5 and centered on the manhole cover for Test #1. At each increment, deflection readings were obtained followed by a (5) minute rest period.

This procedure was followed up to the AASHTO HS-25 wheel load (21,300 LBS) where the assembly was allowed to rest for 10 minutes while deflection readings were obtained every two minutes. Visual documentation of the rings under load was made and photographs taken. The loading was then continued until 150% of the HS-25 wheel load (31,950 LBS) was reached. Again, visual documentation was made and photographs taken.

The load was slowly released, followed by a 10 minute rest period, to allow the ring assembly to rebound. Final visual documentation was made and deflection readings were obtained.

Representative photographs and a sketch of the test assembly are attached to this report.

TEST RESULTS

The HDPE adjusting ring static load tests were performed on November 10 and 11, 1998. Results of the testing are detailed below.

Test #1 - One (1)- 4" and One (1)- 2" Rings

Load (lbs)	Deflection (inches)
21,300	0.181
31,950	0.226

* 5,000 lb load increment not used on this test

The load/deflection data are also shown in the attached graph. Minor deformation in the form of localized bulging (outward) and dimpling (inward) was observed at 21,300 lbs. The deformation was moderate at 31,950 lbs. No cracking occurred within the 2" and 4" ring structures during the test.

Test #2 - Two (2)- 4" and One (1)- 2" Rings

Load (Ibs)	Deflection (inches)
5,000	0.144
10,000	0.178
15,000	0.230
21,300	0.295
25,000	0.338
31,950	0.383
0*	0.094

.• Net deflection after unloading and 5 minute rebound period

The load/deflection data are also shown in the attached graph. Deformation (bulging and dimpling) was more pronounced than in Test #1 at both the 21,300 and 31,950 pound loads, though still in the minor to moderate range. No cracking occurred within the 2" and 4" ring structures during the test.

Test #3 - Three (3)- 4" and Two (2)- 2" Rings

Loads (lbs)	Deflection (inches)
5,000	0.133
10,000	0.215
15,000	0.270

Load (lbs)	Deflection (inches)
21,300	0.342
25,000	0.397
31,950	0.473
0*	0.138

* Net deflection after unloading and 5 minute rebound period

The load/deflection data are also shown in the attached graph. Deformation (bulging and dimpling) was more pronounced than in Test #2 at both the 21,300 and 31,950 pound loads, though still in the moderate range. No cracking occurred within the 2" and 4" ring structures during the test.

Test #4 - One (1)- 4" and One (1)- Slope Ring

Loads (lbs)	Deflection (inches)
5,000	0.066
10,000	0.094
15,000	0.125
21,300	0.154
25,000	0.182
31,950	0.209
0*	0.041

* Net deflection after unloading and 5 minute rebound period

The load/deflection data are also shown in the attached graph. Minor deformation (bulging and dimpling) was observed at the 21,300 and 31,950 pound loads. No cracking occurred within the 2" and 4" ring structures during the test. The slope ring did not induce perceptible lateral movement in the ring stack.

Test #5 - One (1)- 4" and Two (2)- Slope Rings

Load (lbs)	Deflection (inches)
5,000	0.073
10,000	0.107
15,000	0.135
21,300	0.168
25,000	0.192
31,950	0.223
0*	0.048

- Net deflection after unloading and 5 minutes rebound period

The load/deflection data are also shown in the attached graph. Minor deformation (bulging and dimpling) was observed at the 31,950 pound load. No cracking occurred within the 2" and 4" ring structures during the test. The slope ring did not induce perceptible lateral movement in the ring stack.

DISCUSSION

From the graph, it is apparent the load/deflection relationship for the adjusting ring is relatively linear following an initial "seating" period. No failure and minimal plastic yielding occurred under test loads as evidenced by the lack of visible distress and rebound following removal of the load. It is likely some additional rebound would have occurred beyond the five (5) minute period of the test.

The test procedure did not consider the effects of subgrade confinement as will occur in actual field applications. The confining pressure of the soil, base aggregate, or pavement against the rings will reduce overall deformation of the ring stack, resulting in less actual deflection than obtained in the laboratory testing.

REMARKS

The samples will be retained in our lab for a period of 30 days from the date of this report. Contact us if you would like the samples held longer or returned to you.

To protect the client, the public and American Engineering Testing, Inc., this report (and all supporting information) is provided for the addressee's own use. No representations are made to parties other than the addressee.

Report Prepared by:

Daniel J. Larson, P.E.
Principal Engineer

Reviewed by:

Mark L. Tipler
Engineering Assistant

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CONSULTANTS
GEOTECHNICAL
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ENVIRONMENTAL

January 15, 1999

Mr. Gale Jacobsen
LADTECH, Inc.
319 Aster Drive Northfield, MN 55057

Re: HDPE Adjusting Ring Testing Program
AET Job No. 05-00175

Dear Mr. Jacobsen:

American Engineering Testing, Inc. (AET) has completed the testing program for the high-density polyethylene (HDPE) adjusting ring product manufactured by LADTECH, Inc. The scope of our work included subjecting various combinations of adjusting rings to a series of tests and documenting the results.

The following tests were performed as part of our testing program:

- I,005,334-cycle load test with simulated AASHTO HS-25 wheel load
- Static compression testing of 6", 10", and 16" high adjusting ring combinations
- Hot-mix asphaltic concrete exposure and compression testing
- Static compression testing of specimens subjected to 5 ^{o}F. temperatures

The intent of the testing program was to subject the '1djusting rings to load and thermal conditions that may occur in actual field installations.

Summary of Test Results

Overall, the results of our test program indicate the 6", 10" and 16" adjusting ring combinations are capable of supporting an AASHTO HS-25 wheel load. Further, a 2" and 4" ring combination satisfactorily resisted 1,005,334 cycles of a simulated HS-25 'wheel load dropping from a height of 3/4" without· experiencing fatigue cracking or significant permanent deformation.

Exposure of a 2" and 4" adjusting ring combination to asphaltic concrete did not affect the ability of the rings to resist a simulated HS-25 wheel load. The 4" adjusting ring did experience minor peripheral cracking. The cracking did not compromise the water tightness of the system. The 2" adjusting ring did not show any cracking as a result of exposure to the hot asphaltic concrete.

When cooled to 5° F. and tested, adjusting ring coupon specimens resisted a higher compressive load prior to buckling than similar coupon specimens at ambient laboratory temperatures (approximately 70° P.). The mode of failure was ductile (Le., not brittle) in both cases, though the 5° F. specimens had less deformation prior to buckling. No brittle fracture was observed in the 5° F. specimens.

Remarks

The cyclic and static compressive load testing was performed without confinement of the adjusting rings by soil as would occur in field applications. When in place in the field, the external confinement of the adjusting rings will tend to decrease the overal1 deformation of the ring assembly under load. Further, soil restraint will provide lateral resistance to the horizontal loads imposed by moving vehicles, similar to traditional concrete adjusting ring construction.

Reports have been prepared for each of the four test procedures described in this letter. Refer to these reports for more detailed information on the test procedures and results.

Standard of Care

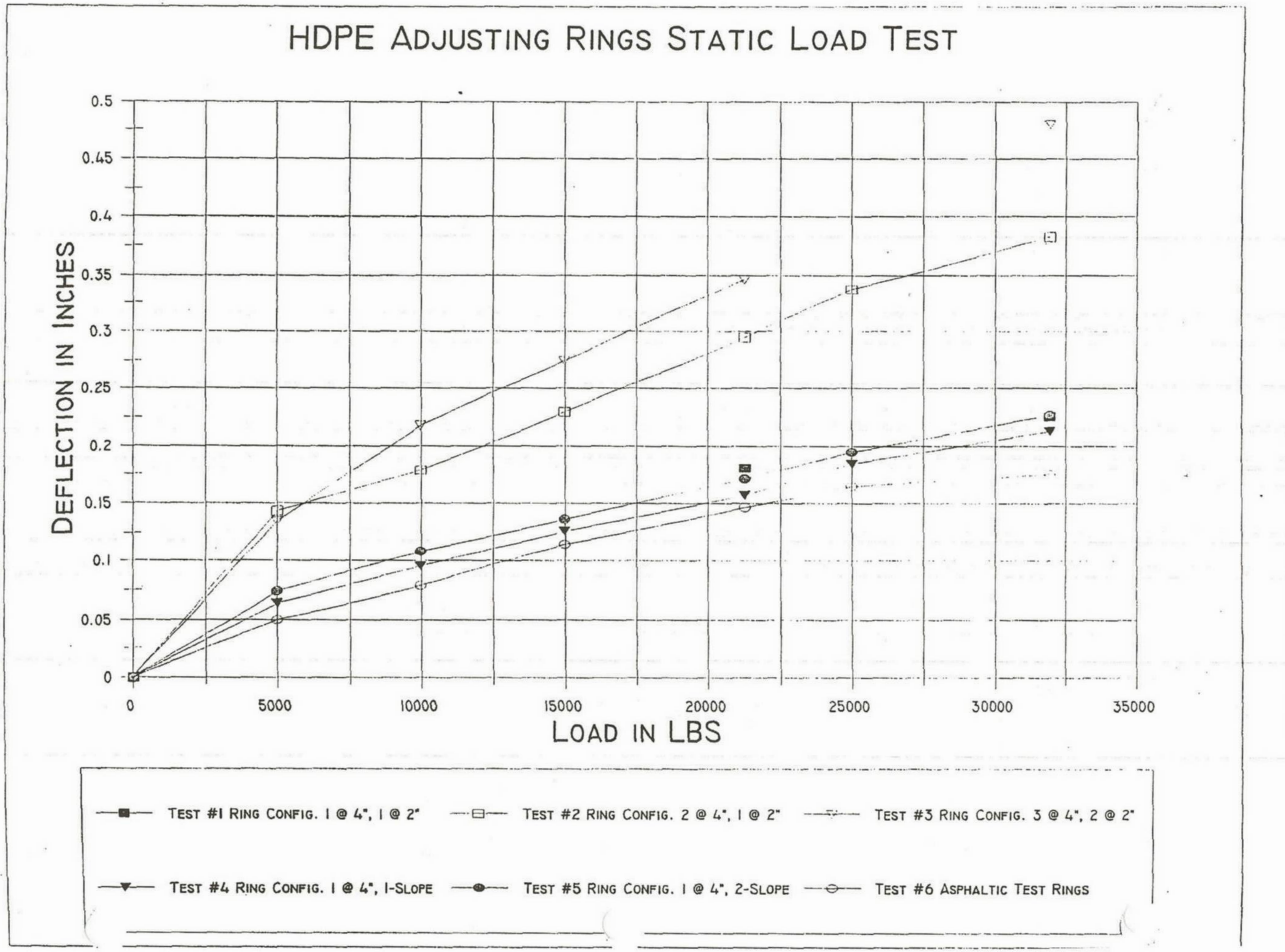
The work performed by American Engineering Testing, Inc. has been conducted in a manner consistent with that level of skil1 and care ordinarily exercised by other members of the profession currently practicing in t1tis area.

Sincerely,

Daniel J. Larson, P.E.
Principal Engineer

DJL/ck

AMERICAN ENGINEERING TESTING, INC., JOB 05-00175



PHOTOGRAPHS
AET JOB NO. 05-00175

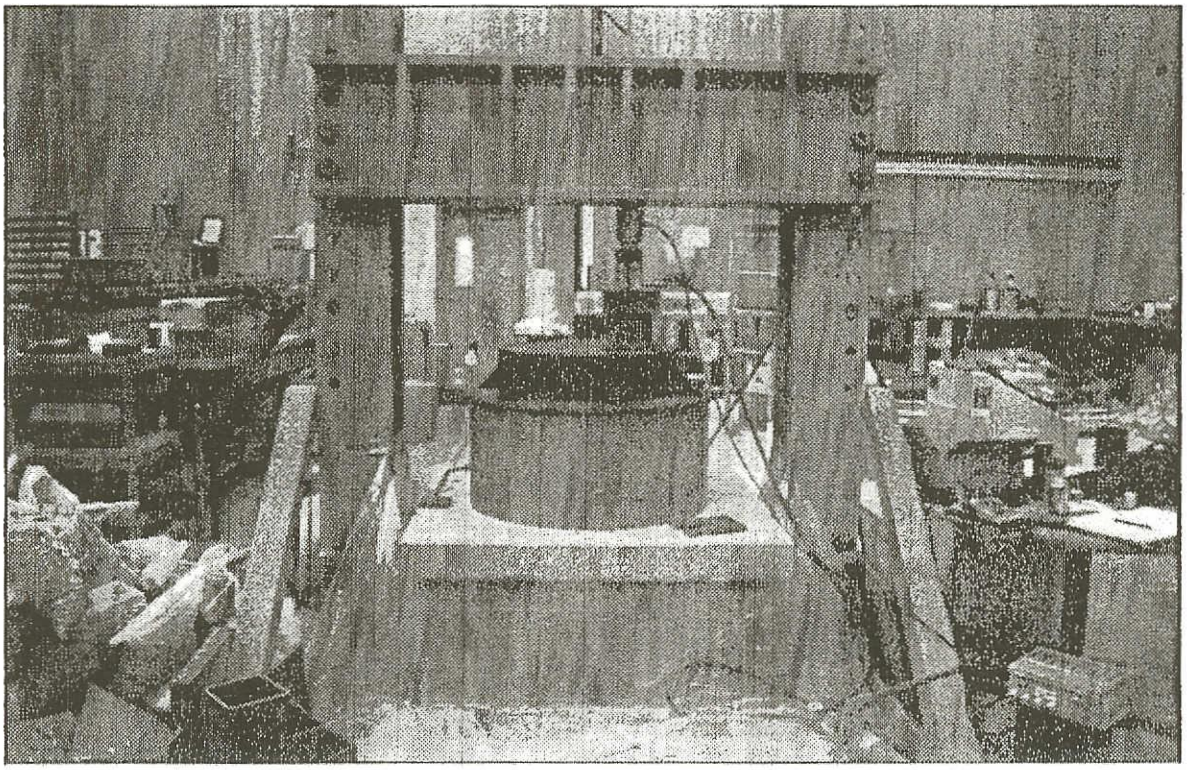
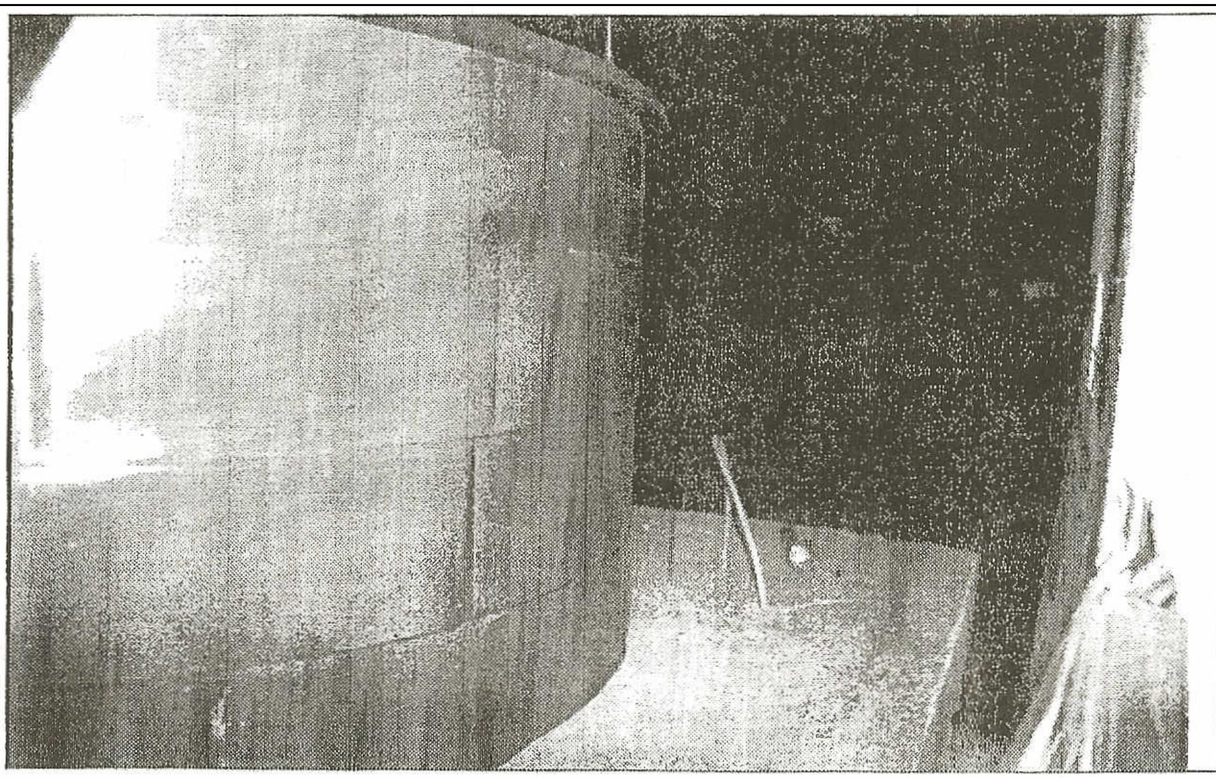


PHOTO 1: Static Load test Set-up, HDPE Adjusting Ring configuration 2 @ 2" and 3@ 4"
PHOTO 2: Static Load @ 3,1950 LBS on HDPE Adjusting Ring configuration 2 @ 2" and 3 @ 4"



PHOTGRAPHS
AET JOB NO 05-00175

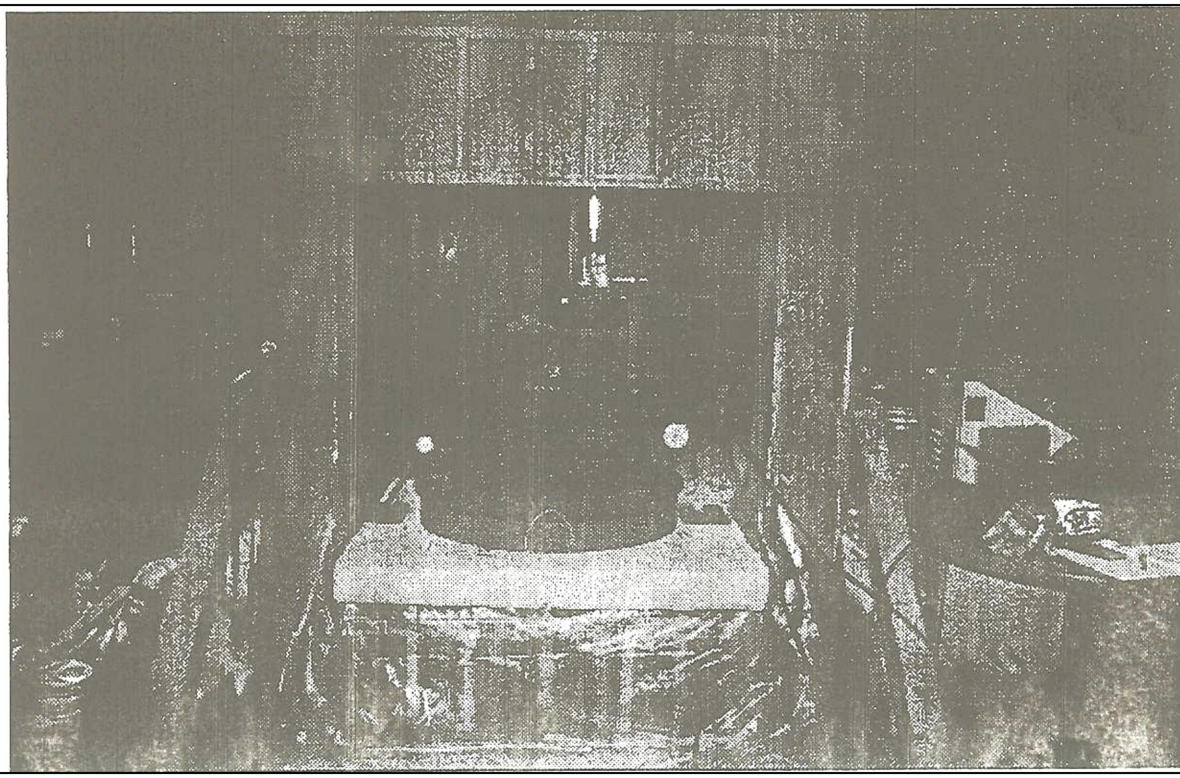
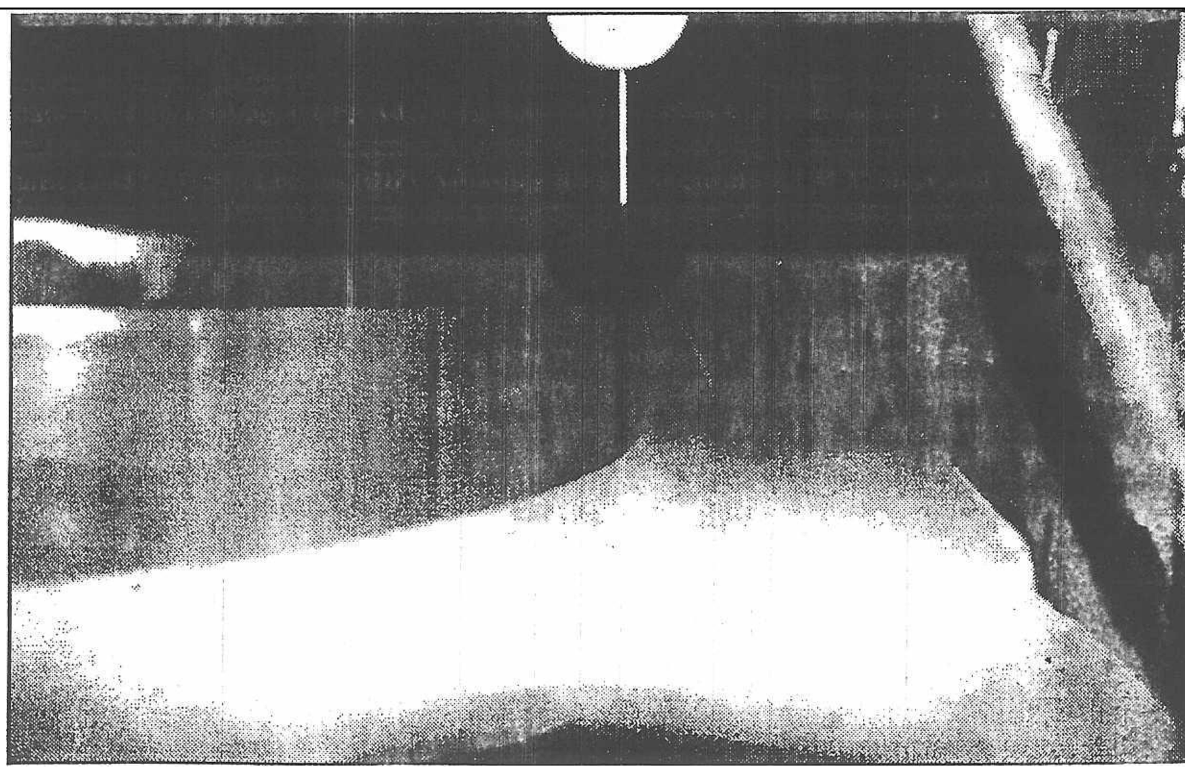


PHOTO 3: Static Load Test Set-up, HDPE Adjusting Ring Configuration 1 @ 1" slope and 1 @ 4"

PHOTO 4: Static Load @ 31,950 LBS on HDPE Adjusting Ring Configuration 1 @ 1" slope and 1 @ 4"



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- MATERIALS
- ENVIRONMENTAL

REPORT OF HDPE ADJUSTING RING HIGH TEMPERATURE TESTING

PROJECT:

HDPE ADJUSTING RINGS
HIGH TEMPERATURE TEST

AET JOB NO: 05-00175

REPORTED TO:

LADTECH, INC.
244 WOODRIDGE LANE
LINO LAKES, MN 55014

ATTN: GALE JACOBSEN

DATE: JANUARY 15, 1999

INTRODUCTION

This report presents the results of testing performed on high-density polyethylene (HDPE) adjusting rings used in conjunction with concrete manhole structures. The scope of our work was limited to the following:

- Subject a stack of HDPE rings to direct contact with hot-mix asphalt concrete
- Document the temperature of the rings at selected locations and times
- Document the condition of the ring stack following removal of the asphalt concrete
- Perform a static load test on the ring stack
- Prepare a report detailing the results of the testing

Our work was requested and authorized by Mr. Gale Jacobsen of LADTECH, Inc. on September 4, 1998, and performed in general accordance with AET Proposal No. 5-98-039, dated July 13, 1998.

BACKGROUND INFORMATION

The adjusting rings are manufactured from 100% recycled plastic. Per LADTECH, the predominant source product for the raw plastic is curbside collected, post-consumer, blow-molded milk and detergent bottles. The bottles are initially manufactured from high density polyethylene as identified by ASTM Standard D-4976. Following shredding and cleaning of the bottles, the rings are manufactured by injection molding techniques.

TEST PROCEDURES

The high temperature test was performed at an asphalt concrete production plant. A concrete spigot measuring 72" outside diameter (o.d.) and 64" inside diameter (i.d.) at the bottom and 68" o.d. and 54" i.d. at the top was used for containment. A concrete pipe section measuring 33'.4" o.d., 24" i.d. and 12" in length was set in the center of the spigot. Recycled Class 5 material (MnDOT 3138.2Al) was then placed and compacted between the confinement spigot and the pipe section up to the top of the pipe. The adjusting ring configuration consisted of one (1) 4" and one (1) 2" ring. Two thermocouples were placed on the outside of the 4" adjusting ring 180^0 from each other. Two thermocouples were placed on the outside of the 2" ring 180^0 from each other and 90^0 from the thermocouples of the 4" ring. One (1) thermocouple was placed on the inside of the 4" ring. A i4" bead of butyl sealant was applied between the top of the pipe section and 4" ring, between the 4" and 2" rings, and between the 2" ring and manhole casting. The thermocouple wires were brought together and protected from the hot asphaltic concrete with a pvc pipe. Monitoring of the temperature change was done using a Kane-May 1242, 5 channel recording thermometer.

Asphaltic concrete conforming to MnDOT Specification 2340 was then placed between the confinement spigot and the adjusting ring assembly up to the top of the manhole casting.

Compaction was achieved using a WP 1550 wacker vibrating compactor. The thermometer was set to record at 5 minute intervals.

After 24 hours, the test assembly was carefully dismantled and the adjusting rings removed. A visual survey of the condition of the adjusting rings was made. The adjusting ring stack was then subjected to a static compression test. Refer to the Report of HDPE Adjusting Ring Static Load Testing for a description of the static test procedure.

Photographs were taken throughout the test. Selected photographs are attached to this report for reference.

TEST RESULTS

The HDPE adjusting ring high temperature test utilizing asphaltic concrete was performed on September 25 and 26, 1998. Results of the test are detailed below.

Visual Observations

The asphaltic concrete temperature was 287° F on delivery which was within the normal placement range. The asphaltic concrete was placed and compacted in three (3) lifts.

The asphaltic concrete was allowed to cool overnight. Prior to dismantling the assembly, the manhole cover was removed for visual observation of the inside surface of the rings. The inside surface did not exhibit any deformation or cracking.

The rings were separated from the asphaltic concrete test assembly. The outside surface of the 4" ring that was subjected to direct contact with the asphaltic concrete exhibited random vertical cracking at the web intersections. The 2" ring did not exhibit similar cracking. of 24 web/flange intersections, eight (8) exhibited cracking that varied from 1/4" to 4" in length and up to 1/8" in width, though most were less than 1/16" in width. Minor deformation of the outside flange of both rings was noted. The butyl sealant between the rings showed signs of distress due to the elevated temperature.

Temperate Readings

The temperature was monitored via the five (5) thermocouples for 22 hours. The recorded temperatures ranged from a maximum of 265°F to a minimum of 88°F. Refer to the attached graph for the temperature change data.

Static Load Test

The ring stack (one (1)- 4" and one (1)- 2" ring) was tested in the laboratory to 150% of AASHTO HS-25 wheel loads (1.5 x 21,300 lbs = 31,950 lbs). The deflection of the ring stack under load was as follows:

LOAD (lbs)	DEFLECTION (inches)
5,000	0.049
10,000	0.076
15,000	0.112
21,300	0.145
25,000	0.163
31,950	0.173

The load/deflection data are also shown in the attached graph. No additional cracking or propagation of existing cracks from the asphaltic concrete test was observed. Minor deformation in the form of localized dimpling and bulging was observed at loads above 21,300 lbs. Of note, some of the cracks caused by the asphaltic concrete test narrowed during the load test.

The 21,300 lb test load (AASHTO HS-25) was held for 10 minutes and the deflection of the ring stack monitored. Additional deflection of 0.003" (2 %) occurred during the 10 minute hold period.

The load was removed and the ring stack was allowed to rebound for a period of five (5) minutes. The deflection in the ring stack after the rebound period was 0.058".

DISCUSSION

In comparing the load/deflection performance of the ring stack exposed to asphaltic concrete with a similar unexposed ring stack, the deflection of the exposed ring stack was actually less than the unexposed stack (0.173" v. 0.226"). Note that these results are for only one test of each stack.

Overall, exposure of the adjusting rings to asphaltic concrete does not appear to adversely affect the compressive strength of the rings within the AASHTO wheel load limits. Consideration should be given to using a heat resistant caulk for adjusting rings that will be subjected to elevated temperatures.

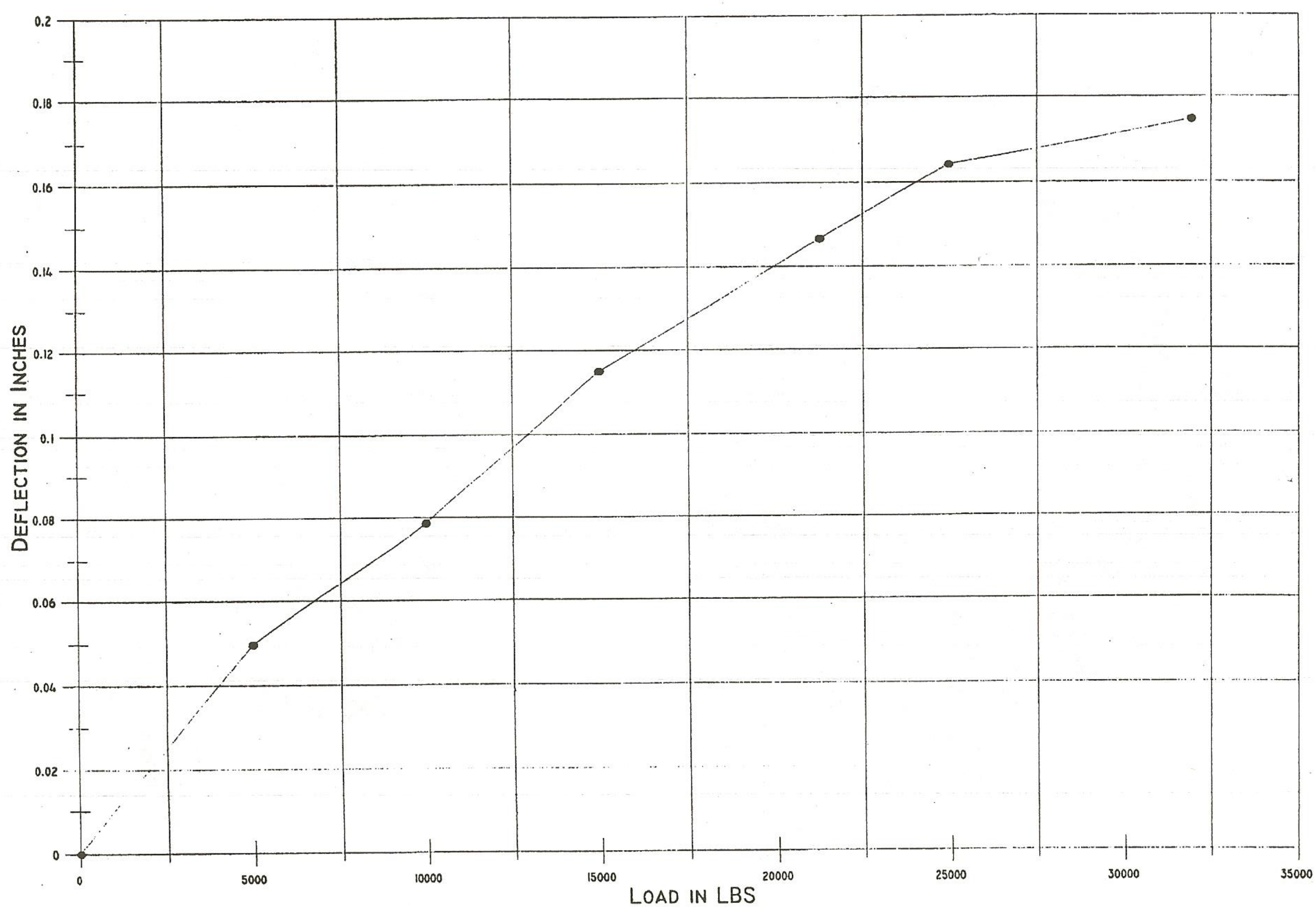
REMARKS

The samples will be retained in our lab for a period of 30 days from the date of this report. Contact us if you would like the samples held longer or returned to you.

Report Prepared by:

Daniel J. Larson, P.E.
Principal Engineer

HDPE Adjusting Rings
Load Testing of Asphaltic Rings



PHOTOGRAPHS
AET JOB NO. 05-00175

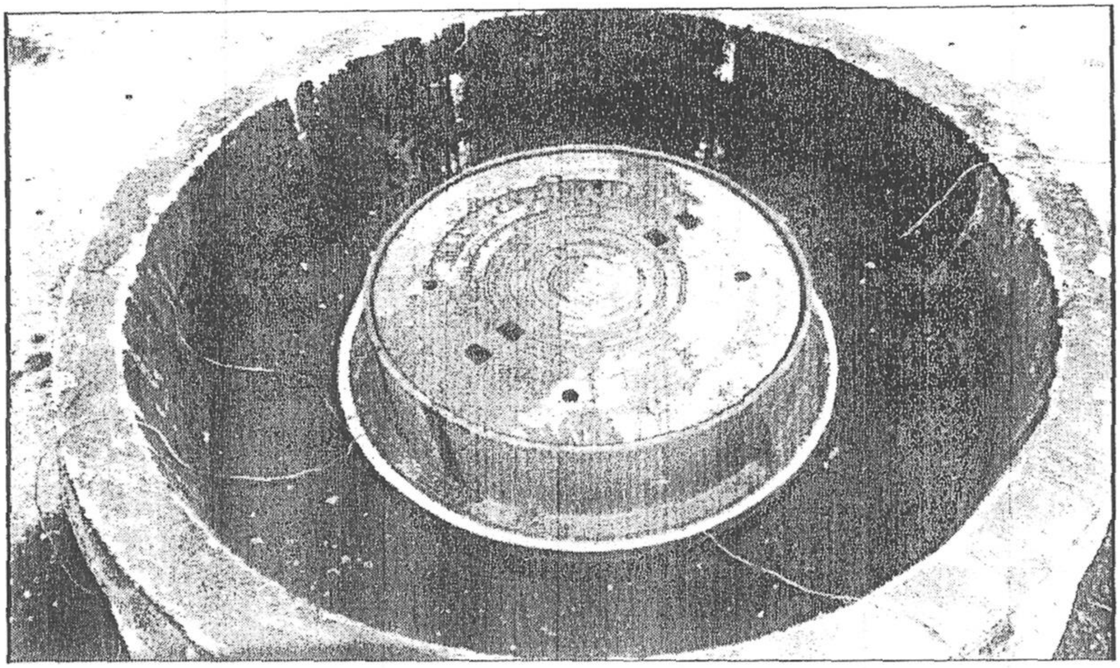
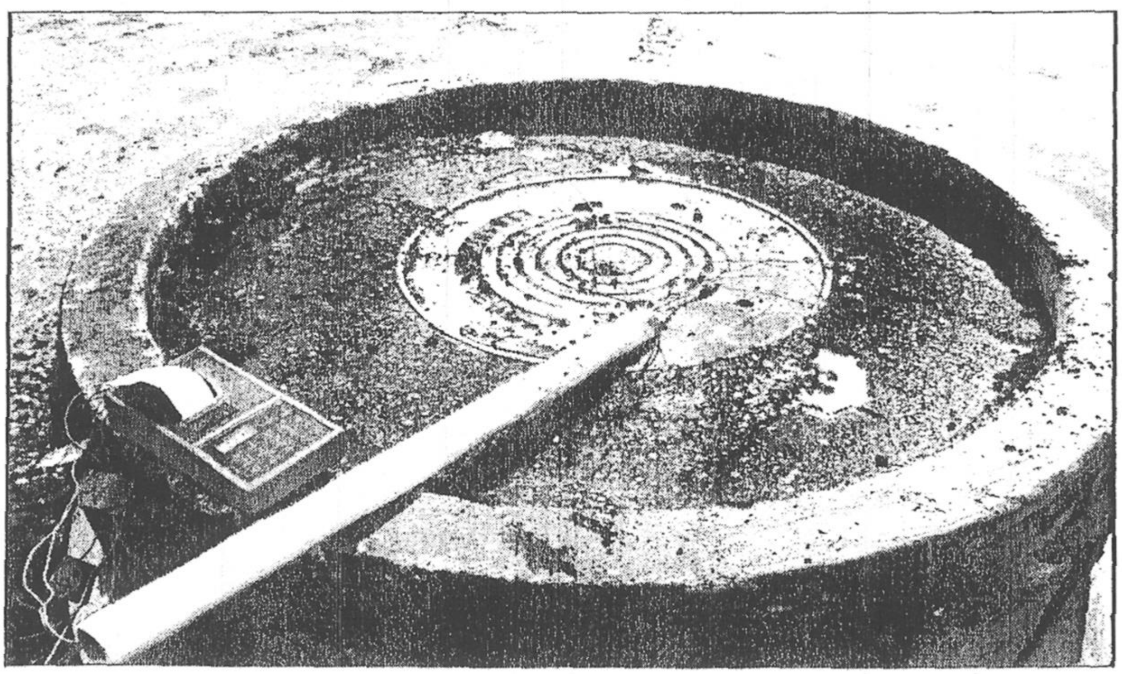


Photo 1: HDPE Plastic Adjusting Rings 1 @ 2" and 1 @ 4" set up and ready for hot asphaltic concrete to be added

Photo 2: Asphaltic concrete added at an average temperature of 287 degrees F, compacted and a 5 channel thermometer recording temperature every five minutes



PHOTOGRAPHS
AET JOB NO. 05-00175

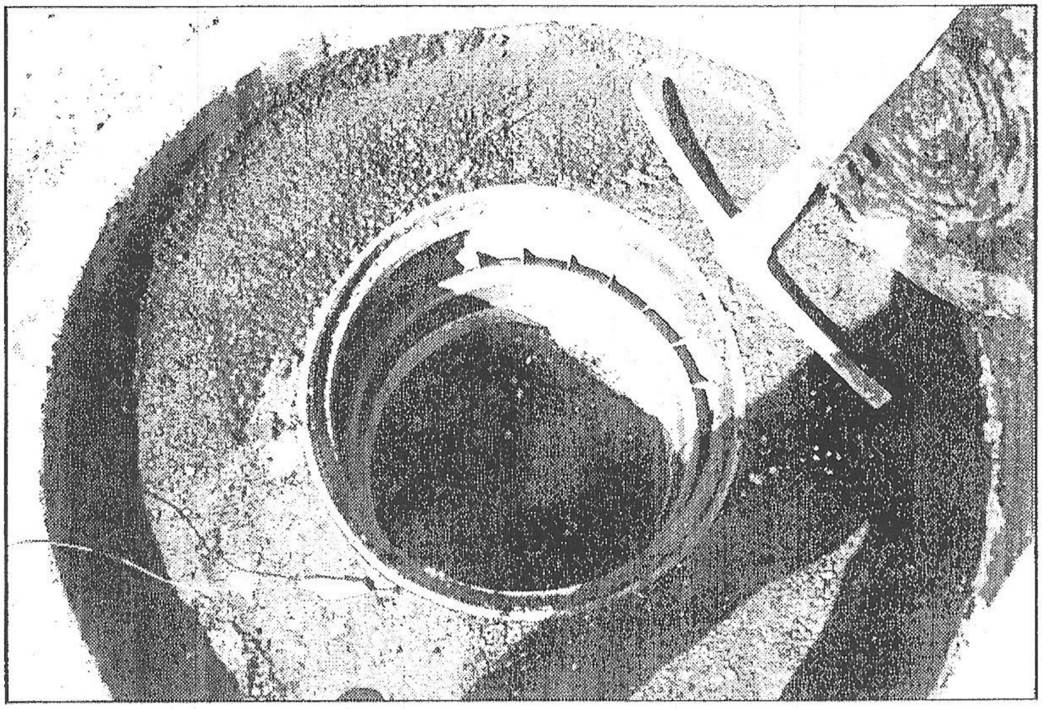
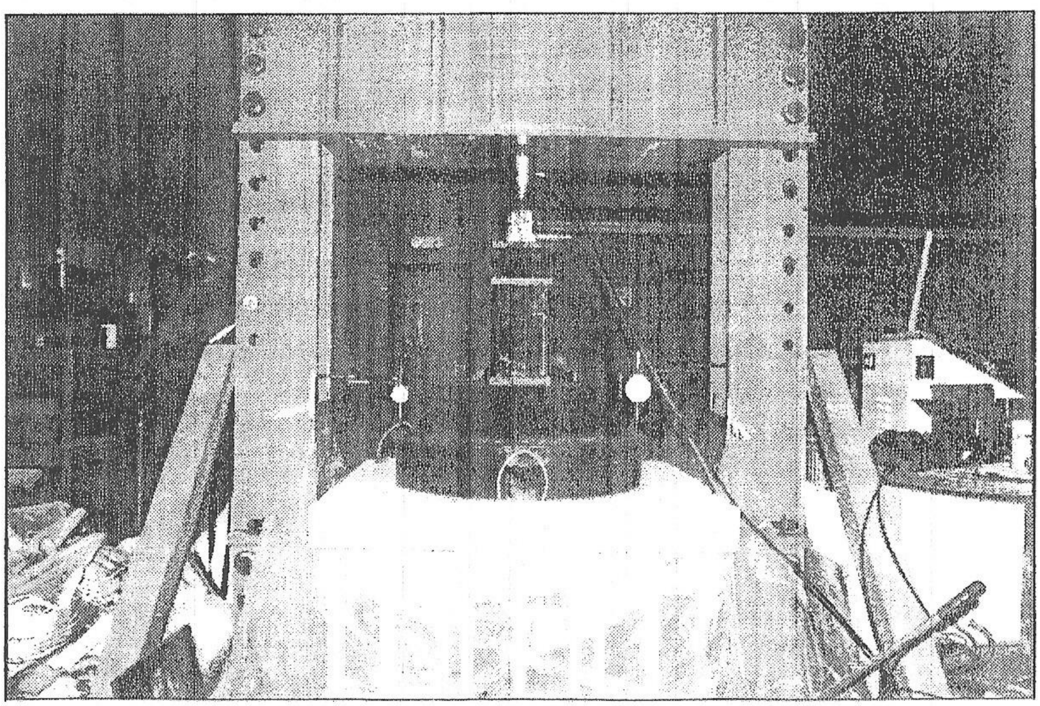


Photo 3: Removal of HDPE Adjusting Rings from the asphaltic concrete testing apparatus

Photo 4: Static testing of HDPE Adjusting Ring from the Asphaltic concrete test



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- MATERIALS
- ENVIRONMENTAL

REPORT OF HDPE ADJUSTING RING LOW TEMPERATURE TESTING

PROJECT:

HDPE ADJUSTING RINGS
LOW TEMPERATURE TESTING

REPORTED TO:

LADTECH, INC.
244 WOODRIDGE LANE
LINO LKAES, MN 55014

ATTN: GALE JACOBSEN

AET JOB NO: 05-00175

DATE: JANUARY 15, 1999

INTRODUCTION

This report presents the results of testing performed on high-density polyethylene (HDPE) adjusting rings used in conjunction with concrete manhole structures. The scope of our work was limited to the following:

- Perform low temperature compression testing of a series of adjusting ring coupon specimens
- Perform compression testing of a series of coupon specimens at ambient laboratory temperatures
- Prepare a report comparing the results of the low and ambient temperature testing

Our work was requested and authorized by Mr. Gale Jacobsen of LADTECH, Inc. on September 4, 1998, and performed in general accordance with AET Proposal No. 5-98-039, dated July 13, 1998.

BACKGROUND INFORMATION

The adjusting rings are manufactured from 100% recycled plastic. Per LADTECH, the predominant source product for the raw plastic is curbside collected, post-consumer, blow-molded milk and detergent bottles. The bottles are initially manufactured from high density polyethylene as identified by ASTM Standard D-4976. Following shredding and cleaning of the bottles, the rings are manufactured by injection molding techniques.

TEST PROCEDURES

The low temperature testing was performed in the American Engineering Testing (AET) laboratory. The loading apparatus consisted of a 1,000,000 pound capacity Forney compression machine with a digital readout. Deflection measurements were obtained with dial gauges accurate to 0.001".

The test coupons were cut from two, 2" whole adjusting rings and consisted of single cell "boxes" (one whole ring consists of 24 cells). The inner alignment flange was cut off to allow the coupon to rest flat in the test assembly. Refer to the attached photographs for a view of the box coupons. A total of 15 coupons were prepared for low temperature testing. A total of 12 coupons were prepared for comparative testing at ambient temperatures.

The low temperature coupons were cooled overnight to approximately 5 OF in a Logan freeze-thaw chamber. The ambient temperature coupons remained in the laboratory at approximately 70°F. At the time of testing, the low temperature coupons were removed one at a time and tested to failure. Deflection measurements were obtained at 500 pound increments. The ambient coupons were tested in a similar fashion.

TEST RESULTS

The HDPE adjusting ring low temperature tests were performed on November 23, 1998. Results of the testing are detailed below.

Low Temperature Coupons

Test Number	Load at Failure (lbs)	Deflection at Failure (in)
1	7,510	0.073
2	7,610	0.095
3	7,530	0.111
4	7,980	0.076
5	7,370	0.062
6	8,010	0.074
7	8,000	0.090
8	7,480	0.074
9	7,500	0.076
10	7,670	0.071
11	7,050	0.073
12	7,690	0.075
13	7,920	0.072
14	8,010	0.078
15	7,380	0.068
Average	7,650	0.078

Ambient Temperature Coupons

Test Number	Load at Failure (lbs)	Deflection at Failure (in)
2	5,970	0.124
3	5,770	0.049
4	5,660	0.075
5	5,900	0.089
6	6,340	0.096
7	5,910	0.084
8	5,900	0.083
9	6,330	0.073
10	6,260	0.067
11	6,060	0.096
12	5,970	0.075
Average	6,010	0.083

The load/deflection data are also shown in the attached graph. The average failure load of the low temperature coupons was 27 % higher than the ambient coupons. The average deflection at failure of the low temperature coupons was 6 % less than the ambient coupons.

The failure mode of both the low temperature and ambient coupons was ductile.

DISCUSSION

The results of the low temperature compression testing compare favorably with the coupons tested at ambient temperatures. The increase in failure load and decrease in deflection of the low temperature coupons can be attributed to the decreased ductility of the coupon specimens at 5 degrees F.

When extrapolating the results of this testing to the static testing of whole ring stacks, the effect of lower temperatures on the performance of the adjusting rings under normal loading is minimal.

REMARKS

The samples will be retained in our lab for a period of 30 days from the date of this report. Contact us if you would like the samples held longer or returned to you.

To protect the client, the public and American Engineering Testing, Inc., this report (and any supporting information) is provided for the addressee's own use. No representations are made to parties other than the addressee.

Report Prepared by:

Daniel J. Larson, P.E.
Principal Engineer

Reviewed by

Signature on Original Document

Mark L. Tyler
Engineering Assistant

PHOTOGRAPHS
AET JOB NO. 05-00175

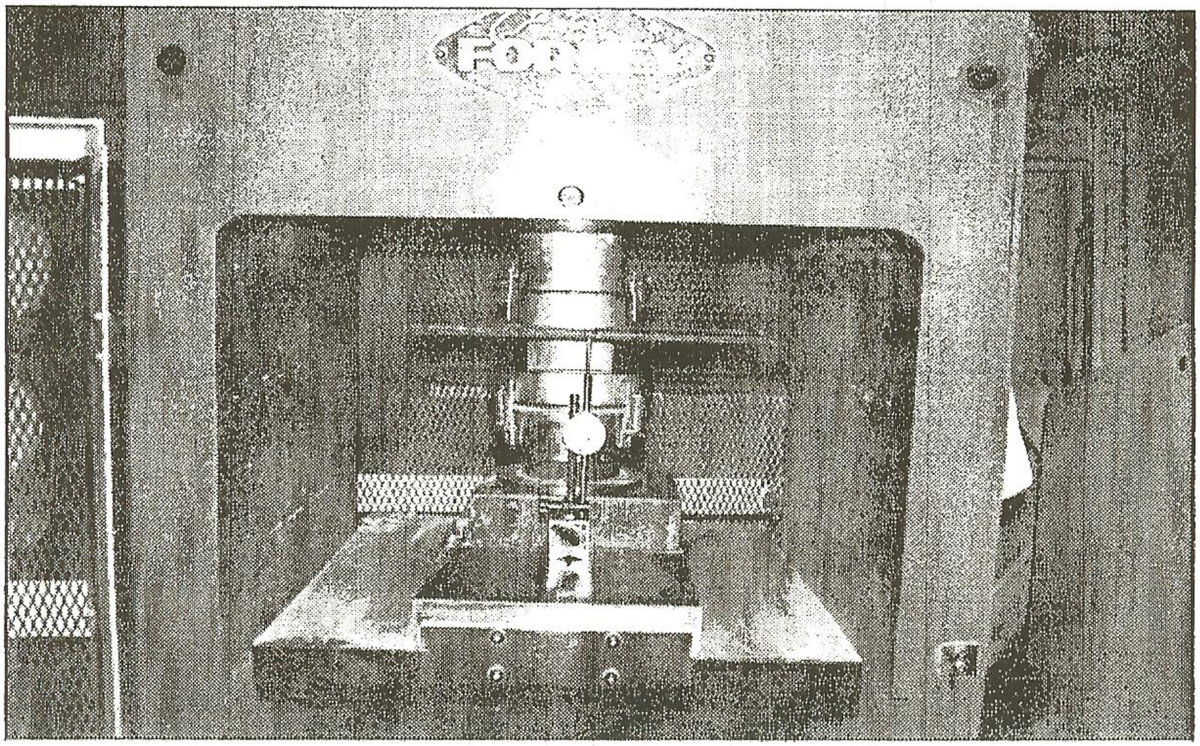
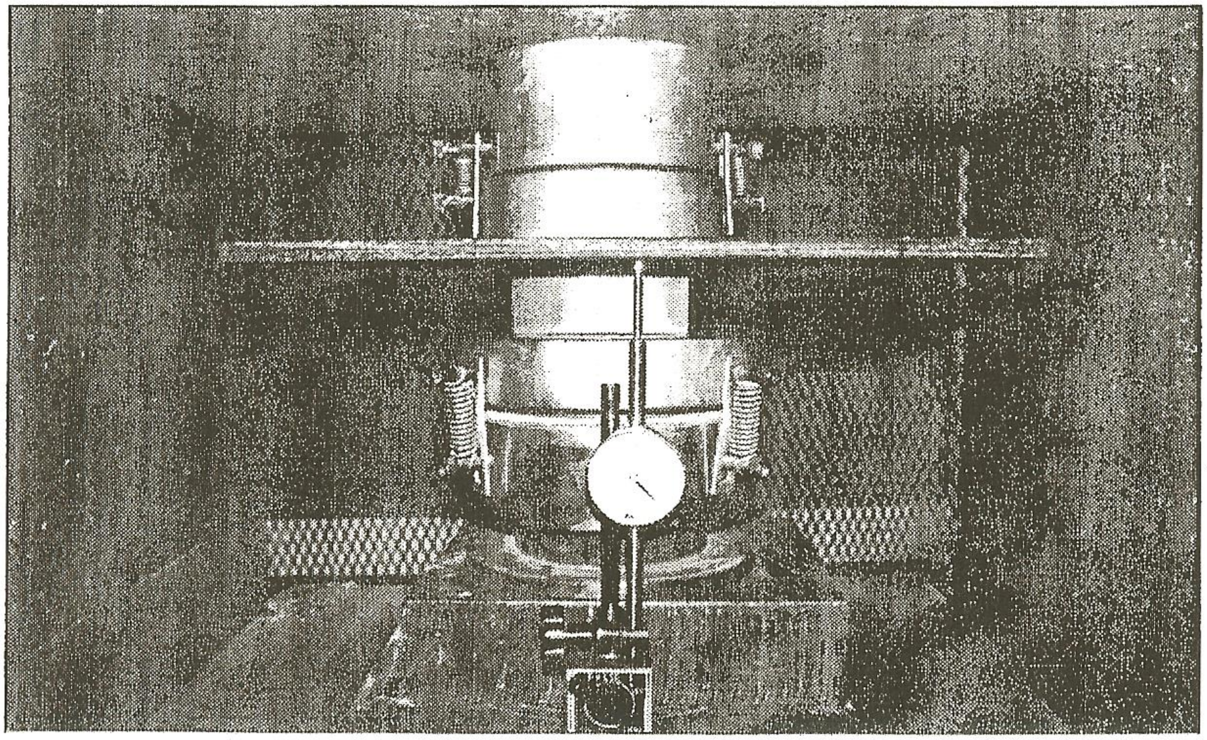
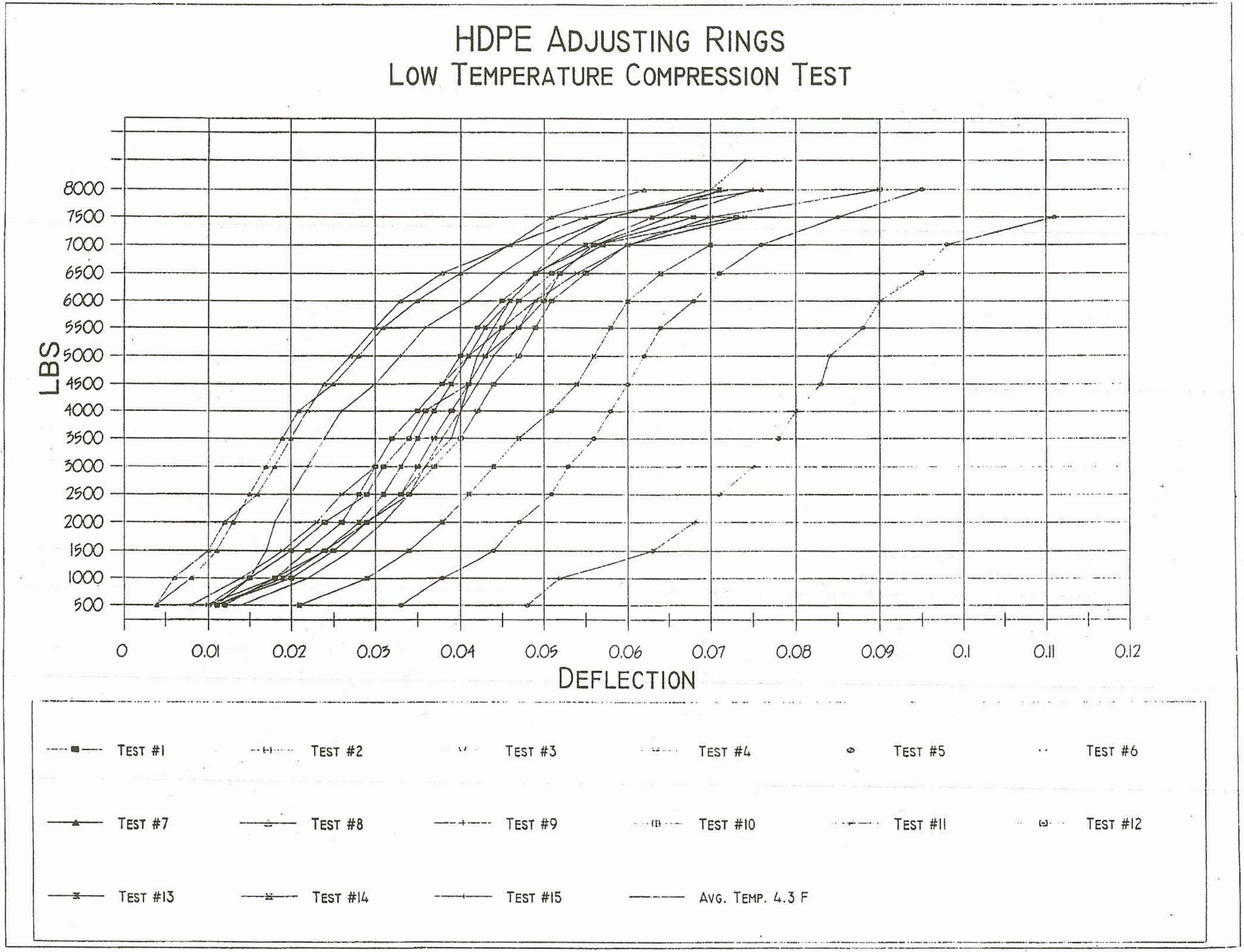


Photo 1: HDPE Adjusting Rings cold temperature test set-up, using one cell of a 2" adjusting ring

Photo 2: Cold temperature testing of HDPE Adjusting rings




HDPE ADJUSTING RINGS
LOW TEMPERATURE COMPRESSION TEST
LBS
8000
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DEFLECTION
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TEST #2
TEST #3
TEST #4
TEST #5
TEST #6
TEST #7
TEST #8
TEST #9
TEST #10
TEST #11
TEST #12
TEST #13
TEST #14
TEST #15
AVG. TEMP. 4.3 F

Chermir / Polytech
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3 May, 1999

Mr. Gale L. Jacobsen
Vice President, Operations
Ladtech, Inc.
319 Aster Drive
Northfield. MN 50057

Rs: Environmental Stress Cracking

P.O. #: Verbal Chemin/Polytech Job #22942

Dear Mr. Jacobsen:

As per your request. we have completed the analysis of your sample "Test Bars" (Chemir/Polytech *990878) determining stress cracking in accordance with ASTM D 1693 • 97a Standard Test Method for Environmental Stress-Cracking of Ethylene Plastics. The results are summarized below

SAMPLE LOG.IN

The Sample was logged as follows:

Sample Description	Chemir/Polytech Sample Number
Test Bars	990878

ANALYSIS RESULTS

Environmental Stress cracking ASTM D 1693 ~ 97a.
No stress cracks were noticed after forty-eight (48) hours of exposure to the reagent Igepal CA-21 0 and 8 mild solution of sulfuric acid with e pH of 5 at 50'C. The test was allowed to continue for a 10181 of on. hundred sixty eight hours (168) hours. There were no stress cracks noticed on any of the twenty specimens up to 168 hours.

ANALYSIS DISCUSSION

Environmental stress cracking ASTM D 1693 • 97a.

AII testing and sample preparation was carried out in accordance with ASTM D 1593-97a
The test method covers the determination of the susceptibility of ethylene plastics to environmental stress cracking when subjected to the conditions herein specified. Under certain conditions of stress and In the presence of environments such as soaps, wetting agents. oils, or detergents, ethylene plastics may exhibit mechanical failure by cracking. Bent specimens of the plastic, each having a controlled Imperfection on one surface are exposed to the action of a surface-active agent. The proportion of the total number of specimens that crack in a given time is observed. Environmental stress-cracking is a property that is highly dependent upon the nature and the level

of the stresses applied and on the thermal history of the specimen. Under the conditions of the test method, high local multiaxial stresses are developed through the introduction of a controlled imperfection. Environmental stress cracking has been found to occur most readily under such conditions. The specimens were cut in accordance to specifications in section 8.2 and placed inside the specimen holder. The holder was then placed inside two test tubes, one containing Igepal CA 210 and the other containing a mild sulfuric acid solution with a pH of 5. The test tubes were then placed into a control chamber at 50°C for 48 hours. Since no stress cracking was observed, the test continued for a total of 168 hours. No stress cracks were observed. Ten specimens were tested for each reagent. The results are summarized in the table below.

ASTM D 1693 - 97a Environmental Stress Cracking.

Identification of Material Tested	Post consumer recycled high-density polyethylene plastic with less than 1-% injection grade polyethylene and polypropylene supplied by Ladtech Inc.
Manner of Preparation of Test Specimens	Injection molded test bars.
Reagent and Strength	Igepal CA 210 - 100%. Mild sulfuric acid solution < 1%. With a pH of 5.
Condition of Test	50.0 ± 0.5 °C.
Duration of Test (Hours)	168 Hours.
Percentage of Specimens That Failed	0
Date of Test	April 28, 1999.

Sincerely,
Chemir / Polytech Laboratories, Inc.

Shri Thanedar, Ph.D.
Technical Director

G. Fred Willard, Ph.D.
Group Leader
Materials Science Section

Project Chemist

Fred Tacker
Lab Technician

ST:jh/Ladtech0499REV2.doc/d4

Enclosures

VERBAGE TO SPECIFY SEALING OF LADTECH PLASTIC ADJUSTMENT RINGS:

Sealing Specification:

EZ – STIK Butyl rubber sealant in Rope form or EZ – STIK #3 Butyl Rubber Sealant in trowelable form as manufactured by Press Seal Gasket Corporation or an approved equal butyl caulking product. Material must meet or exceed the requirements of Federal specifications TT – S- OO1657, ASTM C-990 and AASHTO M-198.

………………………………..

The bottom ring shall be sealed to the manhole cone or top slab using a butyl sealant as specified by the manufacture of the hdpe manhole adjusting rings. This sealant may be in the form of a trowelable caulk or rope. Determination of which sealant form will be dependent on the cone or top slab surface and what is necessary to effect a seal.

The annular space between the hdpe rings shall be sealed with a butyl sealant as specified by the manufacturer of the hdpe manhole adjustment rings. The sealant shall be applied to the vertical surface of the interlocking tongue adjacent to the bottom of the horizontal surface.

The top ring shall be sealed to the bottom surface of the cover frame casting using a butyl sealant as specified by the manufacture of the hdpe adjustment rings. This sealant shall be applied to the upper surface of the top ring in a location to seal against a flat bottom surface of the cover frame.

………………………………….

Frequently asked question: What is the maximum allowed height for a manhole that can be used to install the Ladtech Rings?

OSHA requirements are:

A. With a Step being used, 25" maximum can be used from the top of the asphalt to the first step.
B. Without a Step being used, there is no regulation. You can go as much as 3 feet or more.

902 Barton Ave,
Buffalo MN 55313
adjring@ladtech.com
www.ladtech.com
Toll Free: (877) 235-7464
Toll Free Fax (866) 397-7571

REPORT OF ADJUSTABLE MANHOLE RING – FREEZE TEST

PROJECT:
HDPE ADJUSTABLE MANHOLE RINGS
AET LABORATORY

REPORTED TO:
LADTECH, INC.
6704 MEADOWLARK COURT
LINO LAKES, MN 55038

ATTN: MARTY PITZEN

AET PROJECT NO: 05-06572

DATE: NOVEMBER 20, 2015

INTRODUCTION

American Engineering Testing (AET) has completed the freeze testing on the adjustable manhole rings. Ladtech requested this additional testing on October 27, 2015 to document that the cavities within the manhole rings would remain intact if they were filled with water and allowed to freeze.

TEST PROCEDURES

Two adjustable manhole rings were used for testing. The bottom ring was placed right side up on the floor and the cavities were filled with water. Butyl adhesive was applied to the interior lip of the top ring before being placed on top of the bottom ring. The cavities in the top ring were also filled with water. Concrete blocks were placed on top of the rings to simulate the weight of a frame and cover. The manhole rings were placed in a walk in freezer at a temperature of 0˚F and were left in place for 24 hours. After about 24 hours, the adjustable rings were removed for observations.

RESULTS

We set up the test specimen on November 11, 2015 around 10 am and removed it from the freezer on November 12, 2015 around 10 am. The adjustable manhole rings showed no signs of distress as a result of the water freezing inside the cavities.

LIMITATIONS

Our authorized work scope was limited to our observations in the requested areas only. As such, our conclusions and recommendations pertain only to those areas observed. Should conditions differing from those documented by AET at the time our work be found in the future, AET reserves the right to review our conclusions and recommendations and modify them accordingly.

STANDARD OF CARE

The work performed by American Engineering Testing, Inc., has been conducted in a manner consistent with that level of skill and care ordinarily exercised by other members of the profession currently practicing in this area.

REMARKS

It has been a pleasure to have been of service to you on this project. Should you have any questions or concerns regarding this report, please do not hesitate to contact us.

Report Prepared By:
American Engineering Testing, Inc.

Brandon J Mikelson, EIT
Staff Engineer
Phone: 651-659-1331
bmickelson@amengtest.com

Report Reviewed By:
American Engineering Testing, Inc.

John A. Amundson, PE
Principal Engineer
MN Lic. No. 20838
Phone: 651-659-1361
jamundson@amengtest.com

REPORT OF AQUA X WATER TEST

PROJECT:

HDPE MANHOLE ADJUSTMENT RING
WATER CHAMBER TESTING
AET LABORATORY
ST. PAUL, MINNESOTA

REPORTED TO:

LADTECH, INC.
6704 MEADOWLARK COURT
LINO LAKES, MN 55038

ATTN: MARTY PITZEN

AET PROJECT NO: 05-06572

DATE: SEPTEMBER 22, 2015
UPDATED: OCTOBER 15, 2015

INTRODUCTION

American Engineering Testing (AET) has completed the water sealant testing of the Aqua X foam adhesive. The objective of the testing was to confirm that Aqua X would provide a water tight seal.

CONCLUSIONS

AET has confirmed that the Aqua X will provide a water tight seal based on the results of our testing.

TEST PROCEDURES

Prior to the application of sealants the concrete floor was brushed clean and the manhole rings and concrete manhole cover were wiped clean with a dry rag before applying the Aqua X foam sealant. This process was repeated for each manhole ring layer until the height of the stacked manhole rings was about 6 inches. The sandwiched manhole rings were allowed to cure for about 1 to 1-1/2 hours before water was poured into the center of the rings. The water was poured to a depth of about 5 to 6 inches and was left in place for at least 2 hours to determine if any leaks were present.

RESULTS

We performed a single test of the Aqua X sealant on September 21, 2015 and determined that the Aqua X foam sealant was water tight since no water leaks were observed around the outside edges of the rings while water was present in the center of the sandwiched manhole rings.

Another test was conducted on October 13, 2015. The foam was allowed to cure for 30 minutes before adding water to the center of the manhole rings. This test was left in place for at least 20 hours before removing the water. No leaks were detected after 20 hours. The concrete surface around the exterior side of the manhole rings did not show any moisture.

LIMITATIONS

Our authorized work scope was limited to our observations in the requested areas only. As such, our conclusions and recommendations pertain only to those areas observed. Should conditions differing from those documented by AET at the time our work be found in the future, AET reserves the right to review our conclusions and recommendations and modify them accordingly.

STANDARD OF CARE

The work performed by American Engineering Testing, Inc., has been conducted in a manner consistent with that level of skill and care ordinarily exercised by other members of the profession currently practicing in this area.

REMARKS

It has been a pleasure to have been of service to you on this project. Should you have any questions or concerns regarding this report please contact us.

Report Prepared By:
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Brandon J. Mickelson, EIT
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bmickelson@amengtest.com

Report Reviewed By:
American Engineering Testing, Inc.

William E. Bloemendal, PE
Principal Engineer
MN Lic. No. 19124
Phone: 651-603-6613
wbloemendal@amengtest.com

AMERICAN ENGINEERING TESTING, INC.

October 12, 2010

Mr. Dwight Wiedrich
LADTECH, INC.
6704 Meadowlark Ct.
Lino Lakes, MN 55038

Re: 24" X 36" HDPE Adjusting Rings AET

Re: Project No. 05-04911

Dear Mr. Wiedrich,

American Engineering Testing, Inc. (AET) recently completed a static load testing program on the LADTECH, INC. (LADTECH) 24" x 36" rectangular high-density polyethylene (HDPE) adjusting rings used in conjunction with concrete manhole/catch basin structures. Refer to our "Report of Static Load Testing" dated October 1 1, 2010 for detailed results of the testing.

The rings did not experience any cracking and only minor localized bulging when loaded to 150% of the AASHTO HS-20 wheel load (1.5 x 16,000 lbs = 24,000 lbs). This performance is similar to the results achieved in the 1999 static load testing program on LADTECH 24" diameter circular adjusting rings. Compression of the rectangular ring assemblies under load was somewhat greater than the circular assemblies; this was likely due to geometric differences.

Given that the material composition of the HDPE is the same for both the circular and rectangular rings, we would expect similar performance of the rings when subjected to hot and cold temperatures.

We appreciate the opportunity to perform laboratory testing for LAD TECH. Please contact us should you have any questions regarding our services.

Sincerely,
American Engineering Testing, Inc.

Daniel J. Larson, PE
Principal
MN License No. 19649
Phone: 651-659-1337 Fax: 651-647-2744
dlarson@amengtest.com

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W: www.exova.com

Testing. Advising. Assuring.

Physical Testing on Adjustment Ring Samples

A Report to.:	**Ipex Management Inc.** 2441 Royal Windsor Drive Mississauga, Ontario L5J 4C7
Attention:	**Mr. Gaetano Altomare** **Market Development Manager**
Telephone:	905-403-0264 ext 556
E-mail:	gaetano.altomare@ipexna.com
Report No.:	13-0600157 Revision 1 5 Pages, 5 Figures
Proposal No.:	13-006-161517
Date:	November 26, 2013

1.0 INTRODUCTION

At the request of Ipex Management Inc. (Ipex), Exova performed Physical Testing on Adjustment Ring samples, according with specifications provided by the client.

Ipex submitted three (3) full size adjustment ring specimens for testing. Nine samples of 12 in length were cut off from the full size specimens and allocated with Exova Sample Numbers below:

Exova Sample #	Samples Description
13-0600157-1 to 9	Samples of 12 in (304.80 mm) length, 4.875 in (123.82 mm) depth and 1.9685 in (50 mm) thickness

2.0 OBJECTIVES

The objective of the proposed work was to provide information needed to evaluate the properties of the adjustment ring samples, when subjected to a series of compression load applications.

3.0 INSTRUMENTATION

The following instruments were used to measure and record the load values

10 Kip load cell	MII # 806835
MTS 407 signal conditioner	MII # 806081
Environmental chamber	MII # 804271
Temperature probe	MII # 807887
Calibrated caliper	MII # 800095

4.0 TEST PROCEDURE

The compression test set-up was designed using a servo-hydraulic actuator and a calibrated load cell installed in vertical orientation on a super structure. Each sample was seated on the bottom steel plate which was placed on the test bed and the compression load was applied using an additional steel plate attached to the load cell (support and loading fixtures designed and fabricated by Exova).

The photos of the compression test set-up are presented in Figures 1 to 3.

Three samples were tested at three different temperatures as described in Table 1 below.

Table 1: Environmental Test Conditions

Sample Number	Pre-test Temperature Conditioning
13-0600157-1 to 3	+ 23
13-0600157-4 to 6	-20
13-06-COI 57-7 to 9	+ 30

Prior compression load application each sample was maintained in the environmental at the specified test temperatures for a period of minimum two (2) hours. The compression test was started within one (1) minute after sample removal from environmental chamber.

The photo with example of one batch of samples into the environmental chamber and the shape of the mini specimens are presented in Figures 4 and 5.

The test was performed using smaller samples cut off from full size adjustment ring specimens. The required compression loads were calculated based on full load design of 166.6 KN (for a full size specimen) to develop the same stress on the smaller size samples as explained below.

- Full size specimen area Af = 558.1875 sq-in
- Load bearing surface area of the mini specimens Ams = 58.5 sq-in
- Initial stress on the adjustment unit Si = 14 KN/Af = 38.8541 KPa
- Final stress on the adjustment unit Sf = 166.6 KN/Af = 462.3632 KPa
- Initial load on the mini specimens Lmi = Si x Ams = 1,466.95 N (329.8 lbs)
- Final load on the mini specimens Lmf = Sf x Ams = 17,458.84 N (3,925.1 lbs)

The compression load test sequence, measurements and calculations are described below.

- Measure sample thickness at four locations prior compression and calculate average Do
- Apply initial constant load Lmi = 1,466.95 N, measure the thickness of the sample at the same four locations and calculate initial thickness of the sample prior compression DI
- Apply final load Lmf = 17,458.84 N in 20 seconds (using a ramp rate of 800 N/sec), measure the thickness of the sample at the same four locations and calculate initial compression deformation of the sample D2
- Calculate the initial compression deformation Cdl = DI — D2
- Maintain final load Lmf for a period of 30 minutes then measure the thickness of the sample at the same four locations and calculate the average final compression deformation thickness D3
- Calculate average final compression deformation Cd2 = DI — D3
- Remove the load and allow the sample to rest undisturbed for a period of 30 minutes
- Apply initial constant load Emi, measure the thickness of the sample at the same four locations and calculate the average compression set thickness D4
- Calculate average compression set Cs = DI — D4
- Calculate average initial compression deformation = Cd1/D1)*100 (^{0}/0)
- Calculate average final compression deformation = (Cd2/D1)*100 (^{0}/0)
- Calculate allowable average compression set = (Cs/D1)*100 (^{0}/0)

Maximum allowable percentage compression deformation and compression set for each sample are presented in Table 2 below.

Table 2: Maximum Allowable Compression Deformation and Compression Set

Pre-test Temperature Conditioning (*C)	Maximum Average Initial Compression Deformation (%)	Maximum Average Final Compression Deformation (%)	Maximum Allowable Average Compression Set (%)
+ 30	3.3	7.4	1.3
+ 23	1.9	3.0	0.8
-20	1.1	0.8	0.5

5.0 RESULTS

The calculated deflections for each sample/temperature condition are presented in the Tables 3 to 5 below.

Table 3: Results for + 23*C Test Samples

Description of Measured/Calculated Thickness	Sample Number		
	13-06-C0157-1	**13-0600157-2**	**13-06-C0157-3**
Initial average sample thickness Do (mm)	49.76	49.51	49.51
Sample average thickness prior compression D1 (mm)	49.63	49 39	49.37
Initial average compression deformation thickness D2 (mm)	49.36	49.13	49.12
Initial compression deformation Cd1 (mm)	0.27	0.26	0.25
Final average compression deformation thickness D3 (mm)	49.31	49.06	49.05
Final compression deformation Cd2 (mm)	0.32	0.33	0.32
Average compression set thickness D4 (mm)	49.55	49.31	49.24
Average compression set Cs (mm)	0.08	0.08	0.13
Average initial compression deformation (%)	0.54	0.53	0.51
Average final compression deformation (%)	0.64	0.67	0.65
Allowable average compression set (%)	0.16	0.16	0.26

Table 4: Results for - 20'C Test Samples

Description of Measured / Calculated Thickness	Sample Number		
	13-06-C0157-4	**13-06-C0157-5**	**13-06-C0157-6**
Initial average sample thickness Do (mm)	49.60	49.55	49.49
Sample average thickness prior compression D1 (mm)	49.45	49.40	49.35
Initial average compression deformation thickness D2 (mm)	49.27	49.20	49.17
Initial compression deformation Cd1 (mm)	0.18	0.20	0 18
Final average compression deformation thickness D3 (mm)	49.22	49.15	49.12
Final compression deformation Cd2 (mm)	0.23	0.25	0.23
Average compression set thickness D4 (mm)	49.40	49.34	49.29
Average compression set Cs (mm)	0.05	0.06	0.06
Avera e initial compression deformation (%)	0.36	0.40	0.36
Avera e final compression deformation (%)	0.46	0.51	0.47
Allowable average compression set (%)	0.10	0.12	0.12

Table 5: Results for + 30'C Test Samples

Description of Measured/Calculated Thickness	Sample Number		
	13-06-C0157-7	13-06-COI 57-8	13-06-C0157-9
Initial average sample thickness Do (mm)	49.68	49.72	49.84
Sample average thickness prior compression DI (mm)	49.43	49 58	49.69
Initial average compression deformation thickness D2 (mm)	49.18	49.30	49.39
Initial compression deformation Cd1 (mm)	0.30	0.28	0.30
Final average compression deformation thickness D3 (mm)	49.06	49.21	49.29
Final compression deformation Cd2 (mm)	0.43	0.37	0.40
Average compression set thickness D4 (mm)	49.39	49 49	49.61
Average compression set Cs (mm)	0.09	0 09	008
Average initial compression deformation (%)	0.61	0.56	0.60
Average final compression deformation (%)	0.78	0.75	0 80
Allowable average compression set (%)	0.18	0.18	0.16

The compression test was performed at Exova Mississauga facility on between September 03 and September 06, 2013.

6.0 CONCLUSIONS

The average initial compression deformation, average final compression deformation and allowable average compression set for all tested samples are below the maximum percentage stated in the Table 2 of the present report (Table 1 from "EPS and HDPE Test Procedure 24 Dec 2012 — Maximum Allowable Percentage Compression Deformation and Compression Set for a Single 50 mm Thick Adjustment Unit or Equivalent Sample"). The tested samples meet the "EPS and HDPE Test Procedure 24 Dec 2012, Section TBD.03.03.05 Compression Deformation and Set".

LICENSED PROFESSIONAL ENGINEER
D. P. CHIRA
100135451
PROVINCE OF ONTARIO

Reported by:

Daniel Chira, P.Eng., C.E.T.
Project Manager, Component Testing
Products Testing Group

Reviewed by:

Steven Huynh, P. Eng.
Project Manager
Products Testing Group

Figures

(3 Pages)

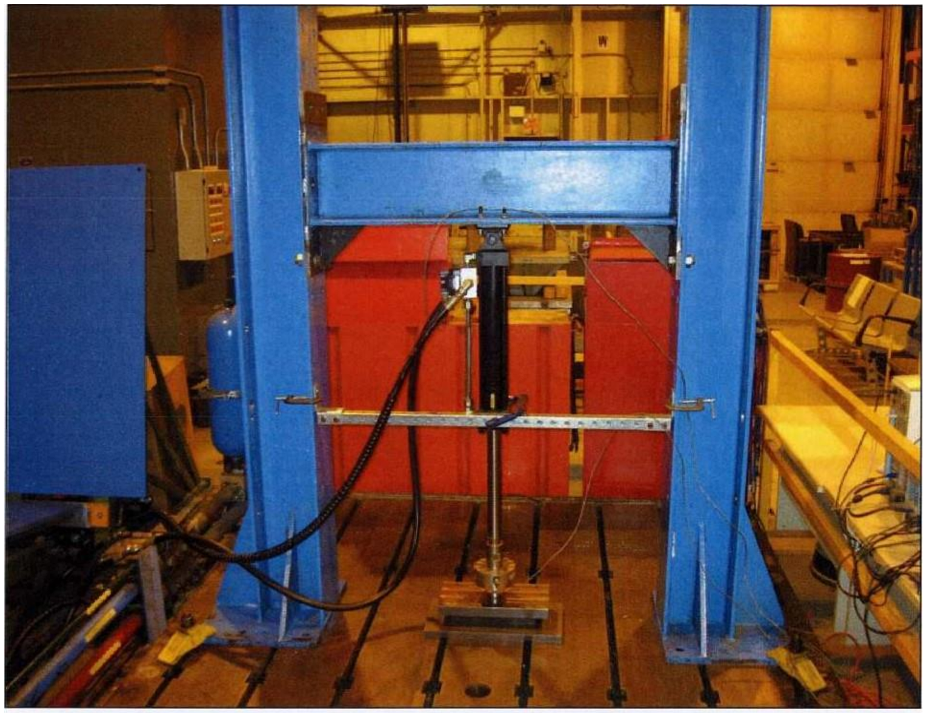

Figure 1: Compression test set-up – General view

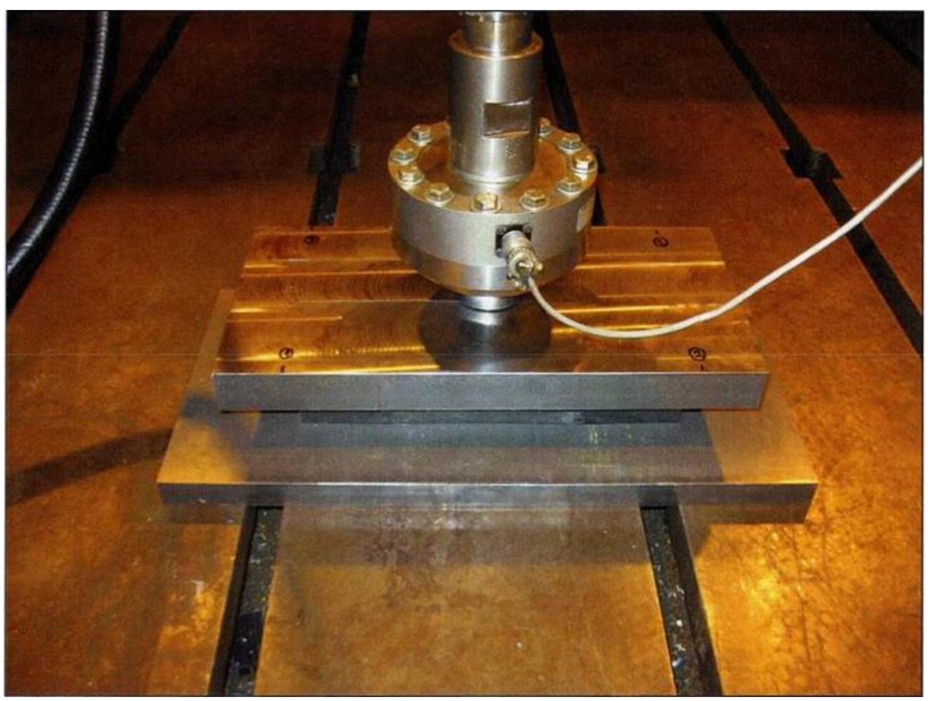

Figure 2: Compression test set-up – Load cell, support and loading fixtures

Figure 3: Compression test set-up – Example of sample installed between fixtures

Figure 4: Example of samples in the environmental chamber

Figure 5: Shape of mini specimens used as test samples

Exova
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Testing. Advising. Assuring.

Durability Testing on Adjustment Ring Samples

A Report to.: **Ipex Management Inc.**
2441 Royal Windsor Drive
Mississauga, Ontario
L5J 4C7

Attention: **Mr. Gaetano Altomare**
Market Development Manager

Telephone: 905-403-0264 ext 556
E-mail: gaetano.altomare@ipexna.com

Report No.: 13-06-C0158
3 Pages, 5 Figures

Proposal No.: 13-006-251905

Date: September 20, 2013

1.0 INTRODUCTION

At the request of Ipex Management Inc. (Ipex), Exova performed Physical Testing on Adjustment Ring samples, according with specifications provided by the client.

Ipex submitted one (1) full size adjustment ring specimens for testing. One sample of 12 in length was cut off from the full size specimen and allocated with Exova Sample Number below.

Exova Sample #	Samples Description
13-06-COI 58-1	Sample of 12 in (304.80 mm) length, 4,875 in (123 82 mm) depth and 1.9685 in (50 mm) thickness

2.0 OBJECTIVES

The objective of the proposed work was to provide Information needed to evaluate the properties of the adjustment ring samples, when subjected to durability compression load testing.

3.0 INSTRUMENTATION

The following instruments were used to measure and record the load values:

10 Kip load cell	Mll # 806835
MTS 407 signal conditioner	Mll # 806081

4.0 TEST PROCEDURE

The durability compression test set-up was designed using a servo-hydraulic actuator and a calibrated load cell installed in vertical orientation on a super structure. The sample was seated on the bottom steel plate which was placed on the test bed and the compression load was applied using an additional steel plate attached to the load cell (support and loading fixtures designed and fabricated by Exova).

The photos of the compression test set-up are presented in Figures 1 to 3.

The sample was tested for compression durability at ambient temperature.

The test was performed using a smaller sample cut off from full size adjustment ring specimen. The required compression durability load was calculated based on full compression durability load design of 98 KN (for a full size specimen) to develop the same stress on the smaller size sample as explained below.

- Full size specimen area Af = 360,142.75 sq-mm (558.1875 sq-in)
- Load bearing surface area of the mini specimen Ams = 37,744.20 sq-mm (58.5 sq-in)
- Compression durability load on full size adjustment unit L = 98 KN (22,030.4 lbs)
- Durability stress on full size adjustment unit S = L/Af = 271.98 KPa (39.4677 Psi)
- Compression durability load on small size sample adjustment unit LS S*Ams 10.27 KN (2,308.9 lbs)

The compression durability test was performed using a sine wave of 0/10.27 KN (0/2,308.9 lbs) at a frequency of 1 Hz (1 cycle/ second) until failure occurs or maximum required number of cycles of 1,000,000 was achieved.

The sample was periodically inspected (once per day or every 86,400 cycles) for deformations and cracks (test stopped, sample removed from set-up and visually inspected) then the test was resumed.

At the test completion (13000,000 cycles achieved) a throughout Inspection regarding deformations and cracks was performed on the sample using a magnifying glass.

5.0 RESULTS

No deformations, cracks or other failures were observed during durability testing and at the final inspection,

The photo of the sample after durability test completion is presented in Figure 5.

The compression durability test was performed at Exova Mississauga facility on between September 06 and September 19, 2013.

6.0 CONCLUSIONS

The sample meets the "EPS and HDPE Test Procedure 24 Dec 2012", Section TBD.01.01 b) regarding the pass/fail criteria at the compression durability test.

LICENSED PROFESSIONAL ENGINEER
D. P. CHIRA
100135451
PROVINCE OF ONTARIO

Reported by:	Reviewed by:
Daniel Chira, P.Eng., C.E.T.	Steven Huynh, P.Eng.
Project Manager, Component Testing	Project Manager, Component Testing
Products Testing Group	Products Testing Group

Figures

(3 Pages)

Figure 1: Sample before durability testing

Figure 2: Compression durability test set-up – General view

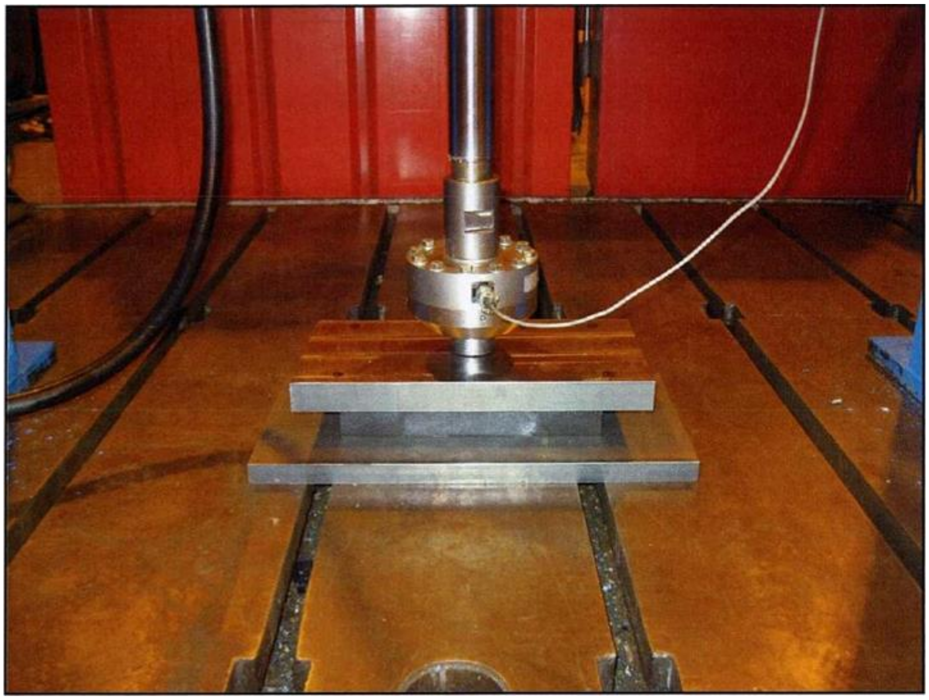

Figure 3: Compression durability test set-up – Load cell, support and loading fixtures

Figure 4: Compression durability test set-up – Example of sample installed between fixtures

Figure 5: Sample after durability testing

Item List

Installation Procedure

(English and Espanol)

LADTECH INCORPORATED

Product Information Sheet

Item Number	*Use for Manhole Size*	*Adjustment Height*	*Pallet Count*	*Part Weight oz./lbs.*	*Pallet Weight Lbs.*	*Size in Cubic Feet*	*Stack Height*	*Pallet Dimensions*
24R125	24"	1 1/4"	69	68 oz. (4 lbs. 4 oz.)	313	61.5	91"	34x34x94
24R150	24"	1 1/2"	58	76.64 oz. (4 lbs. 13 oz.)	299	61.5	92"	34x34x95
24R200	24"	2"	43	92.32 oz. (5 lbs. 12 oz.)	268	61.5	91"	34x34x94
24AL200	24"	2" Recessed Lip	43	73.28 oz. (4 lbs. 10 oz.)	217	61.5	91"	34x34x94
24FCAN-200	24"	2"	43	80.96 oz. (5 lbs. 1 oz.)	238	61.5	91"	34x34x94
24R400	24"	4"	21	172.48 oz. (10 lbs. 13 oz.)	246	60.9	89"	34x34x92
24S150	24"	3/4" to 1 1/2"	79	67.36 oz. (4 lbs. 4 oz.)	353	62.9	92"	34x34x95
SP24FS-025	Final Grade	24" x 1/4"	100	51.52 oz. (3 lbs. 4 oz.)	342			34x34
27R125	27"	1 1/4"	69	72.64 oz. (4 lbs. 9 oz.)	333	72.9	91"	37x37x94
27R150	27"	1 1/2"	58	80.64 oz. (5 lbs. 1 oz.)	312	73.7	92"	37x37x95
27R200	27"	2"	43	96.96 oz. (6 lbs. 1 oz.)	281	72.9	91"	37x37x94
27R400	27"	4"	21	179.2 oz. (11 lbs. 3 oz.)	255	72.1	89"	37x37x92
27S150	27"	3/4" to 1 1/2"	79	74.56 oz. (4 lbs. 11 oz.)	388	74.5	92"	37x37x95
SP27FS-025	Final Grade	27" x 1/4"	100	56.8 oz. (3 lbs. 9 oz.)	375			37x37
30F150	30"	1 1/2"	58	80.96 oz. (5 lbs. 1 oz.)	314	86.1	92"	40x40x95
30F225	30"	2 1/4"	38	115.2 oz. (7 lbs. 3 oz.)	294	86.1	90"	40x40x93
30F400	30"	4"	21	182.72 oz. (11 lbs. 7 oz.)	260	84.3	89"	40x40x92
30S225	30"	1 1/2" to 2 1/4"	47	101.12 oz. (6 lbs. 5 oz.)	317	85.2	91"	40x40x94
SP30FS-025	Final Grade	30" x 1/4"	100	59.2 oz. (3 lbs. 11 oz.)	390			40x40
32F200	32"	2"	43	106.88 oz. (6 lbs. 11 oz.)	307	93.9	91"	42x42x94
32F300	32"	3"	29	146.72 oz. (9 lbs. 3 oz.)	286	93.9	92"	42x42x95
32RFG300	32"	3" Fiber Glass	29	142.08 oz. (8 lbs. 14 oz.)	278	93.9	92"	42x42x95
32S225	32"	1 1/4" to 2 1/4"	51	102.08 oz. (6 lbs. 6 oz.)	346	93.9	91"	42x42x94
SP32FS-025	Final Grade	32" x 1/4"	100	68.96 oz. (4 lbs. 5 oz.)	451			42x42
34F200	34"	2"	43	108.32 oz. (6 lbs. 12 oz.)	311	93.9	91"	42x42x94
34F300	34"	3"	29	141.6 oz. (8 lbs. 14 oz.)	277	93.9	92"	42x42x95
34S225	34"	1 1/4" to 2 1/4"	51	**88.64 oz. (5 lbs. 9 oz.)**	**303**	93.9	91"	42x42x94
SP34FS-025	Final Grade	34" x 1/4"	100	62.72 oz. (3 lbs. 15 oz.)	412			42x42
36F125	36"	1 1/4"	69	114.88 oz. (7 lbs. 3 oz.)	515	104.4	91"	48x40x94
36F225	36"	2 1/4"	38	160 oz. (10 lbs.)	400	103.3	90"	48x40x93
36F300	36"	3"	29	182.08 oz. (11 lbs. 6 oz.)	350	105.5	92"	48x40x95
36S250	36"	1 1/2" x 2 1/2"	42	148.48 oz. (9 lbs. 5 oz.)	410	104.4	91"	48x40x94
SP36FS-025	Final Grade	36" x 1/4"	100	**87.04 oz. (5 lbs. 7 oz.)**	**564**			48x40
2424F150	24"x24"	1 1/2"	58	112 oz. (7 lbs. 0 oz.)	426	62.2	92"	34x34x95
2424F200	24"x24"	2"	43	137.92 oz. (8 lbs. 10 oz.)	391	62.2	91"	34x34x94
2424F275	24"x24"	2 3/4"	32	181.76 oz. (11 lbs. 6 oz.)	384	61.5	93"	34x34x96
2424S125	24"x24"	1 1/4" to 2 3/4"	44	128.64 oz. (8 lbs. 1 oz.)	374	61.5	93"	34x34x96
2424S275	24"x24"	2" to 2 3/4"	38	155.2 oz. (9 lbs. 11 oz.)	389	63.6	94"	34x34x97
SP2424FS-025	Final Grade	24" x 24" 1/4" sq.	100	75.84 oz. (4 lbs. 12 oz.)	494			34x34
2436F150	24"x36"	1 1/2"	58	131.52 oz (8 lbs. 4 oz.)	497	83.3	92"	34x46x95
2436F200	24"x36"	2"	43	169.6 oz. (10 lbs. 9 oz.)	476	83.3	91"	34x46x94
2436F275	24"x36"	2 3/4"	32	198.4 oz. (12 lbs. 6 oz.)	417	83.3	93"	34x46x96
2436SX175	24"x36" Slope	1 1/4" to 1 3/4"	58	133.12 oz. (8 lbs. 5 oz.)	503	83.3	92"	34x46x95
2436SX275	24"x36" Slope	3" leg	44	162.56 oz. (10 lbs. 3 oz.)	467	83.3	93"	34x46x96
24S36X275	24" Slope x 36"	2" leg	44	157.12 oz. (9 lbs. 13 oz.)	452	83.3	93"	34x46x96
SP2436FS-025	Final Grade	24" x 36" 1/4" rec.	100	95.04 oz. (5 lbs. 15 oz.)	614			34x46

ALL ORDERS ARE FOB SPARTA, WI 54656

PALLETS ARE APPROXIMATELY 4.5' HIGH

Pallets weigh approximately 20 lbs. Weight is included in stack weight.

1. The first step is to make sure you have a clean installation area. Be sure to clean the concrete cone or top slab with a whisk broom or chisel. This will assure a flat seating surface free of rocks, gravel, blacktop, protruding concrete or frozen debris.

2. With the installation area now clean, measure the distance from the cone or top slab to the projected finish grade. When making this measurement, be sure to deduct the distance, or height, of the cover frame. Determine the net build-up of rings necessary to come within a 1/4 inch of the grade with the cover frame in place.

3. Now that you have your preliminary measurements, you will need to determine the best ring height combination to attain the necessary adjustment for your specific installation. In cases where grades are not flat, use slope rings to accommodate for this difference.

4. With the measurements determined and your required rings selected, dry stack the rings on the cone or top slab. Index any slope rings as necessary. With the rings dry-stacked, place the cover frame casting on top of the assembly and verify the height and slope match.

5. When the assembly is in place and you have your desired height and slope, mark the entire stack with a vertical line of spray-paint. Once you have your line, disassemble the set-up.

6. You are now ready to begin the actual installation. With all rings within arm's reach, apply a 3/16 to 1/4 inch bead of approved caulk butyl sealant or a 3/8 inch round rope ASTM C-990 to the cone or top slab following the male tongue as a guide. If the cone or top slab is extremely rough, a second bead can be added approximately in the middle of the flat. This is done to assure a complete seal. PLEASE NOTE that it may be necessary to create a flat sealable surface using mortar if the cone or top slab is too badly chipped up prior to installing the ring.

7. With the sealant applied, place the first ring down onto the cone or top slab with the male lip into the opening. Make sure to line up your paint strip. In most cases, this first ring will fit securely into the opening.******* Apply a 3/16 to 1/4 inch bead of an approved caulk butyl sealant or a 3/8 inch round rope ASTM C-990 on the bottom of the next ring following the male tongue as a guide. Be sure to apply the sealant to the male lip ensuring that it covers the entire 360 degrees of the ring

8. As before, place the second ring down onto the first with the male lip interlocking into the center of the first ring. For each ring, make sure to line up your paint strip.

9. Repeat the assembly as you did in the prior steps for each additional ring, applying the bead of sealant and placing the rings on top of one another being sure to line up the paint strip.

10. At this point, you will have all the rings stacked with the sealant applied.

11. You will now proceed to install the cover frame. Prior to setting it in place, apply a 3/16 to 1/4 inch bead of the approved caulk butyl sealant or a 3/8 inch round rope ASTM C-990 on the top of the last ring. Be sure to apply the sealant in a location so that it contacts the cover frame the full 360 degrees. If necessary, you may apply a double bead of sealant.

12. With the sealant applied, set the cover in place verifying that it is centered on the top ring.

13. At this point, the installation of your LADTECH adjustment rings is complete.

13 a. As you can see you can immediately back fill the installation area and proceed to your next installation site.

LADTECH System™
HDPE MANHOLE ADJUSTING RINGS

13 b INSTALLATION COMPLETE!!

**The cone or top slab may be eccentric or undersized and may not allow the ring to sit flush. In this case, the lip on the adjustment ring may be cut as necessary to allow the ring to sit flush and align on the manhole assembly

1. First, determine the amount of lip to be removed.
2. Using a common carpenter's saw, make a perpendicular cut at each end of that distance, being careful NOT to cut into the base surface of the ring. Hold the saw flush against the lip's mounting surface and proceed to cut off the portion of the lip between the two perpendicular Cuts. **CAUTION:** BE SURE NOT TO cut beyond the perpendicular cuts you have made.
3. The ring can now be installed flush to the manhole, top slab or cone assembly utilizing the approved butyl sealant.

1. El primer paso es tener un área de instalación limpia. Limpie bien el cono o la losa superior de concreto con una escobilla o espátula. Esto asegurará una superficie de asentamiento pareja, sin piedras, grava, alquitrán, concreto o restos congelados.

2. Una vez limpia el área de instalación, mida la distancia del cono o losa superior a la explanada final proyectada. Al medir, no olvide deducir la distancia o altura del marco de recubrimiento. Determine la acumulación neta de anillos necesaria para quedar a 1/4 de pulgada de la explanada con el marco de recubrimiento puesto.

3. Ya que tiene las mediciones preliminares, deberá determinar la mejor combinación de alturas de anillo para lograr el ajuste necesario para su instalación específica. Si el terreno no es plano, use anillos con declive para compensar la diferencia.

4. Una vez hechas las mediciones y escogidos los anillos necesarios, apílelos en seco en el cono o la losa superior. Coloque anillos con declive según corresponda. Con los anillos apilados en seco, coloque la pieza fundida del marco de recubrimiento sobre el conjunto y revise que la altura y el declive coincidan.

5. Cuando el conjunto esté instalado y tenga la altura y declive deseados, marque toda la pila con una línea vertical de pintura en lata. Una vez hecha la línea, desarme el conjunto.

6. Ya está todo listo para empezar la instalación real. Con los anillos al alcance del brazo, aplique una capa de 3/16 a 1/4 de pulgada de sellante de butilo aprobado o una cuerda de 3/8 de pulgada de ASTM C-990 al cono o la losa superior siguiendo la lengüeta como guía. Si el cono o losa superior es sumamente rugoso, puede agregar una segunda capa aproximadamente al medio de la superficie plana. Esto asegura un sellado completo. TENGA PRESENTE que tal vez se deba usar mortero para crear una superficie plana sellable, si el cono o losa superior está muy picado antes de instalar el anillo.

7. Con el sellante aplicado, coloque el primer anillo en el cono o losa superior con el reborde dentro de la abertura. No olvide alinear la línea pintada. Generalmente, este primer anillo calzará bien en la abertura.*** Aplique una capa de 3/16 a 1/4 de pulgada de sellante de butilo aprobado o una cuerda de 3/8 de pulgada de ASTM C-990 en la parte inferior del próximo anillo siguiendo la lengüeta como guía. Al aplicar el sellante en la lengüeta, asegúrese de que cubra los 360 grados del anillo.

8. Como antes, coloque el segundo anillo sobre el primero con el reborde calzando en el centro del primer anillo. No olvide alinear la línea pintada en cada anillo

9. Repita los pasos anteriores de ensamblaje para cada anillo adicional, aplicando una capa de sellante y colocando los anillos uno sobre otro alineando la línea pintada

10. En este momento, todos los anillos están apilados y con sellante.

11. Ahora hay que instalar el marco de recubrimiento. Antes de instalarlo, aplique una capa de 3/16 a 1/4 de pulgada de sellante de butilo aprobado o una cuerda de 3/8 de pulgada de ASTM C-990 en la parte superior del último anillo. Aplique el sellante en un lugar en que haga contacto con el marco en todos los 360 grados. De ser necesario, puede aplicar dos capas de sellante.

12. Una vez aplicado el sellante, coloque el recubrimiento en su lugar, debe quedar centrado en el anillo superior

13. Con esto concluye la instalación de los anillos de ajuste LADTECH.

13 a. Como ve, se puede rellenar casi inmediatamente el área de instalación y proceder a la siguiente obra

LADTECH System™
HDPE MANHOLE ADJUSTING RINGS

13 b LA INSTALACIÓN ESTÁ LISTA!!

**Si el cono o losa superior es irregular o muy pequeño, el anillo no quedará nivelado. En este caso, se puede cortar el reborde del anillo de ajuste según sea necesario para que el anillo quede nivelado y alineado en la cámara.

1. Primero, determine el monto de reborde a cortar.
2. Con un serrucho de carpintero normal, haga un corte perpendicular en cada extremo de dicha distancia teniendo cuidado de NO cortar la base del anillo. Con el serrucho al ras contra la superficie de montaje del reborde, corte la porción de reborde entre los dos cortes perpendiculares. PRECAUCIÓN: ASEGÚRESE de no cortar más allá de los cortes perpendiculares que hizo.
3. Ahora el anillo puede instalarse nivelado en el cono o losa superior de la cámara con sellante de butilo aprobado

LADTECH, INC.
CATCH BASIN INSTALLATION INSTUCTIONS
(FOR NEW CONSTRUCTION AND REHABILITATION)

Square or Rectangular

1. Remove existing casting and rings or cover plate to expose concrete structure.

2. Stretch string line or position straightedge to determine height adjustment required.

3. Combine various ring heights, in both flat and slope, to reach desired adjustment. Rings are to be placed with pocket openings down and tabs extending into structure or lower rings. Note: Slope rings are tapered from side to side at an angle to prove a 1% to 3% grade compensation.

4. If offset of rings is needed to achieve casting-to-curb alignment, use a saw to remove interlocking tabs from underside of ring(s) as necessary. Removal of tabs from one side of end of ring will allow up to 2" of offset. Offset should not exceed this amount per ring. Removal of tabs from more than one side will allow for rotation of the rings. Note: Total offset of all rings should not exceed 4" without a concrete collar being poured to maintain stability and integrity of structure. NOTE: NO BUTYL MATERIAL is required between rings