Manhole Renewal

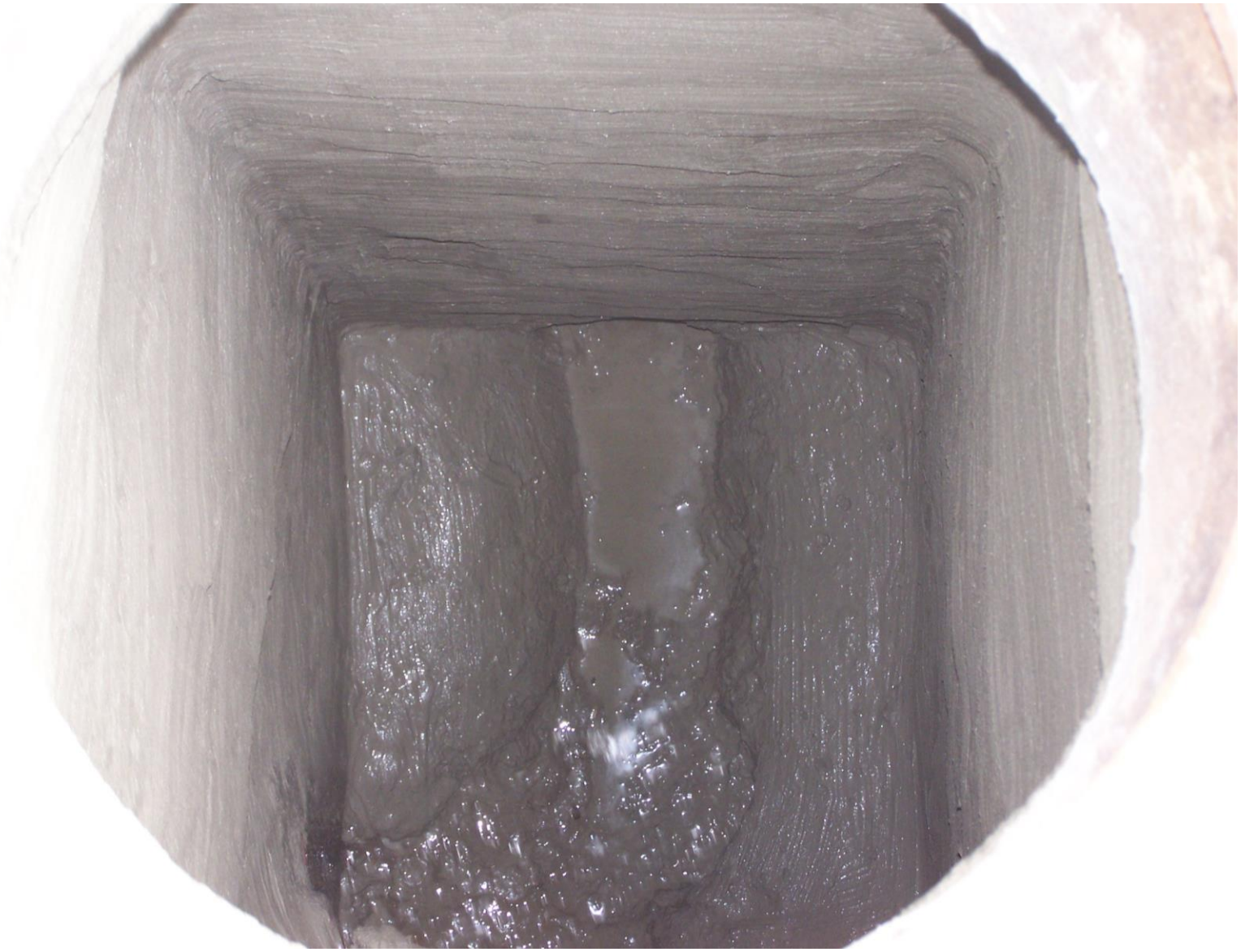
Cementitious Lining

What happens if you choose not to renew?


DEETER FOUNDRY
LINCOLN NE


10/18/2006


08/03/2009 13:09
183010



ADVANTAGES

QUICK – 3 man crew averages 4 to 8 manholes per day in just one set up

WATER TIGHT – seamless shell withstands ground water pressures >100'

STRUCTURAL – combination of strength and thickness restores full value

COST EFFECTIVE – $1,000 to $1,500 per average manhole

VERSATILE – low tech hand spray-trowel or high tech precision placement with spincaster

EASY TO INSPECT – wet gage thickness and C-109 cube test

CORROSION RESISTANT – option: type of cement or special MIC additive

EASE OF ACCESS – equipment easily transported to remote sites

ADAPTIVE – *any diameter * any depth * any shape

SMALL FOOTPRINT – compact equipment in one traffic lane

NON-DISRUPTIVE – sewer flows can be active or internally diverted

PREPARATION – pressure wash and surface can remain wet

Designation: F 2551 – 09

Standard Practice for Installing a Protective Cementitious Liner System in Sanitary Sewer Manholes[1]

This standard is issued under the fixed designation F 2551; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

INTRODUCTION

A sanitary sewer manhole may be repaired or rehabilitated by applying a prepackaged cementitious liner to the interior surface after it has been properly prepared and cleaned. Sanitary sewer manholes can be damaged by dynamic loading, abrasion, erosion, and corrosion.

1. Scope

1.1 This specification describes all the work required to structurally reinforce, seal, and protect sanitary sewer manholes. Applications include applying a prepackaged cementitious liner that can function as a full depth restoration or a partial depth repair. A uniform high-strength, fiber-reinforced cementitious mortar should be manually sprayed and hand troweled or centrifugally cast in a uniform, prescribed thickness to all cleaned, interior surfaces from the bottom of the frame to the bench. The cementitious liner may be applied to manholes constructed of brick, concrete, block, and various other materials.

1.2 A manufacturer's approved applicator shall furnish the complete application of the protective, prepackaged cementitious liner material. All of the cleaning, preparation, and application procedures shall be in accordance with the manufacturer's recommendations.

1.3 The values stated in inch-pound units are to be regarded as standard. The values given in parentheses are mathematical conversions to SI units that are provided for information only and are not considered standard.

1.4 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use. Manholes are permit required confined spaces in accordance with OSHA definition and should be treated as such, requiring confined space entry permits, appropriate monitoring equipment, and the associated personal protective equipment.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

C 39/C 39M Test Method for Compressive Strength of Cylindrical Concrete Specimens
C 109/C 109M Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2-in. or [50-mm] Cube Specimens)
C 309 Specification for Liquid Membrane-Forming Compounds for Curing Concrete
C 494/C 494M Specification for Chemical Admixtures for Concrete
C 969 Practice for Infiltration and Exfiltration Acceptance Testing of Installed Precast Concrete Pipe Sewer Lines
C 1140 Practice for Preparing and Testing Specimens from Shotcrete Test Panels
C 1244 Test Method for Concrete Sewer Manholes by the Negative Air Pressure (Vacuum) Test Prior to Backfill
C 1315 Specification for Liquid Membrane-Forming Compounds Having Special Properties for Curing and Sealing Concrete
F 2414 Practice for Sealing Sewer Manholes Using Chemical Grouting

2.2 *ACI Standards:*[3]

ACI 301-05 Specifications for Structural Concrete
ACI 305R-99 Hot Weather Concreting
ACI 306R-88 Cold Weather Concreting
ACI 308R Practice for Curing Concrete
ACI 506R Guide to Shotcrete

[1] This practice is under the jurisdiction of ASTM Committee F36 on Technology and Underground Utilities and is the direct responsibility of Subcommittee F36.20 on Inspection and Renewal of Water and Wastewater Infrastructure.
Current edition approved May 1, 2009. Published June 2009.

[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

[3] Available from American Concrete Institute (ACI), P.O. Box 9094, Farmington Hills, MI 48333-9094, http://www.concrete.org.


630-627-6163

The Practical Design Approach to Cementitious Liners for the Rehabilitation of Cylindrical-shaped Manhole Structures

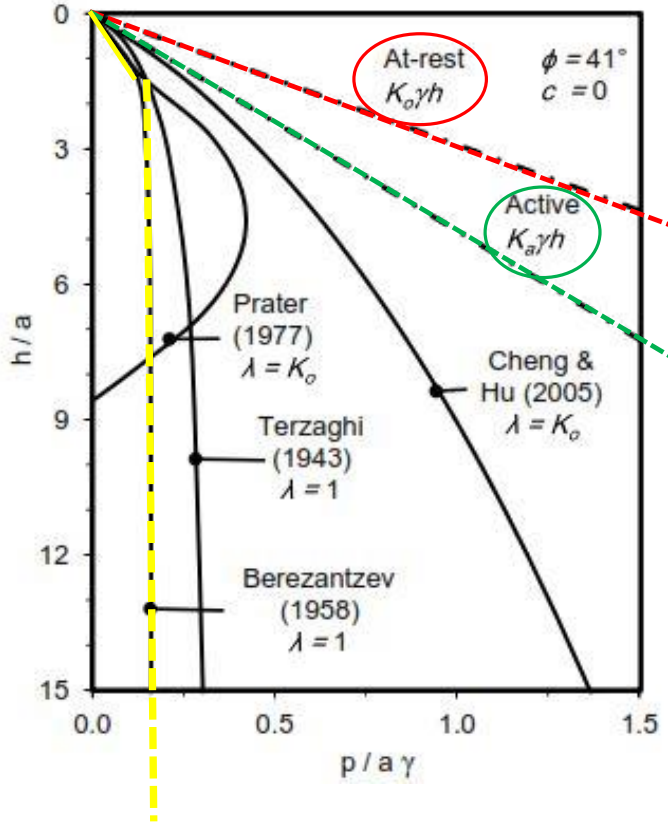
Norman E. (Ed) Kampbell, PE
Rehabilitation Resource Solutions, LLC

Manhole Rehabilitation Materials:

- Polymeric Coatings and Liners (bonded)
  - Epoxy resins
  - Fiber-reinforced epoxy resins
  - Polyurethane resins
  - Polyurea resins
- Engineered Cementitious Liners (bonded)
  - Portland cement mortars
  - Micro-silica mortars
  - Calcium aluminate mortars
- Composite Liner/Coating Systems (i.e. epoxy resin coating over cementitious liner)
- Shell Liner Systems (un-bonded sleeve type liner; such as CIPP, Polyurea, and Polyurethane)
  - Cured-in-Place thermoset resin liners
  - Polyurethane resins
  - Hybrid polyurea resins
  - Polyurea resins

What are the loads acting on a vertically-oriented, buried cylinder?

Soil loads… and how they vary w/ depth



$P_H = \gamma hK$; per Rankine

Results reported by Kim (2013) obtained from full-scale field testing done on cylindrical shafts confirmed the following:

1. The magnitude and the distribution of the lateral earth pressure acting on a vertical circular shaft is not linearly increasing with depth.

2. The impact of the coupled three-dimensional arching effect significantly reduces the lateral earth pressure acting on the shaft. The maximum reduction is approximately 80%. Therefore, a commonly used method like the Rankine theory for calculating the lateral pressure on these type structures can substantially overestimate the lateral pressure in real world situations.

3. The arching effect is generally more significant for deep excavation depths than for shallow excavation depths.

Pitt noted on moment inducing loads….

"The most common and possibly the only source of moment inducing loads on vertical structures such as manholes is from traffic passing near the structure. The obvious load is a wheel on the lid. A simple calculation shows a 10,000 lb. wheel load induced stress along the axis of a one-half inch thick ring demands about 270 psi compressive strength. Both of the mortars used in this research can develop such strength in a few minutes.

Of more significance to these structures are horizontal stresses transmitted through the soil. Pavement reduces the problem by dissipating vertical stress on the soil. Burmister developed a means of computing stress dissipation which is dependent on geometry and modulus of the soil and pavement materials. Spangler's solution for lateral surcharge stresses on a vertical wall can be applied if it is assumed the wall is replaced by an imaginary plane intersecting the tangent of the cylindrical manhole."

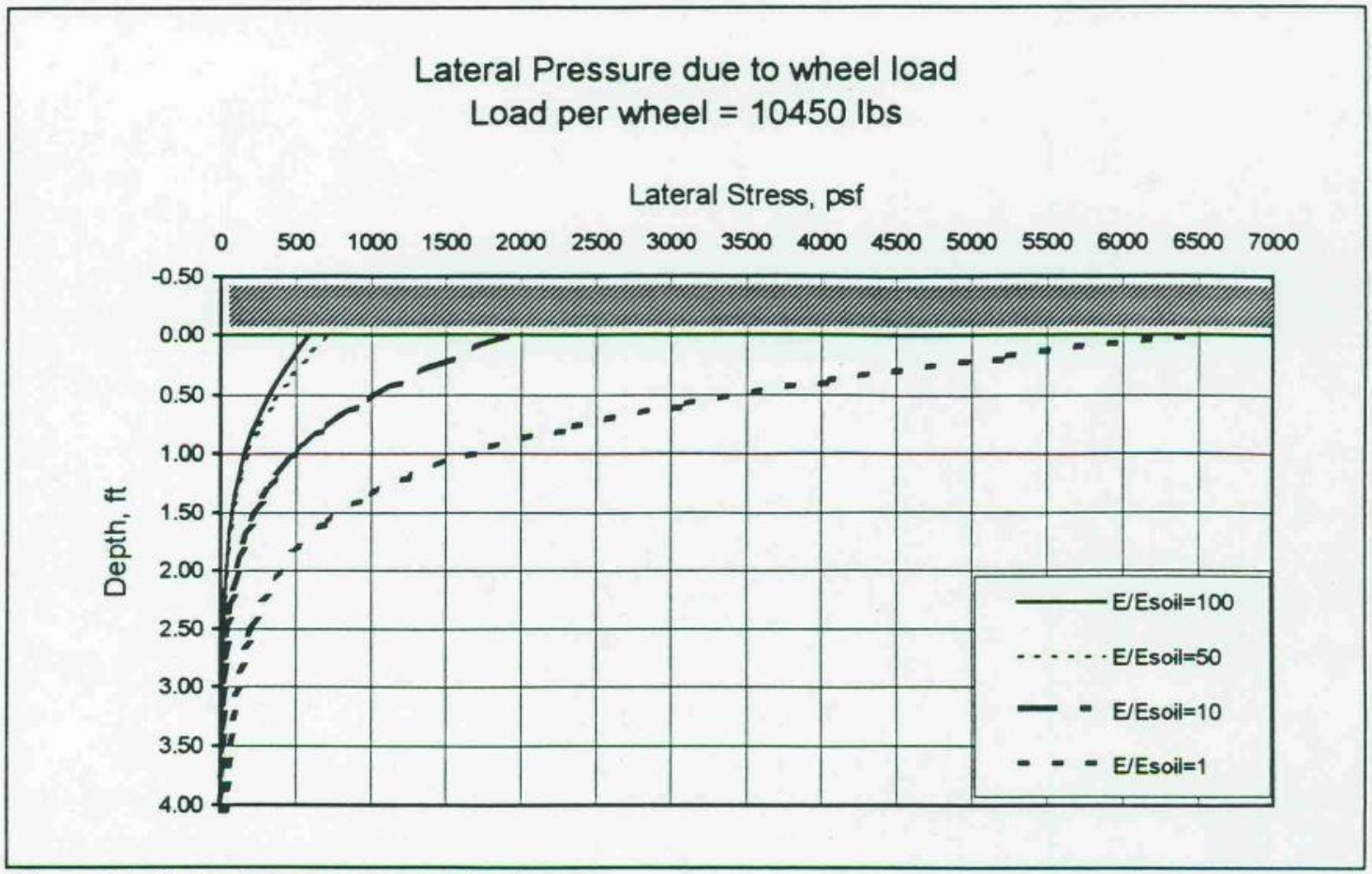


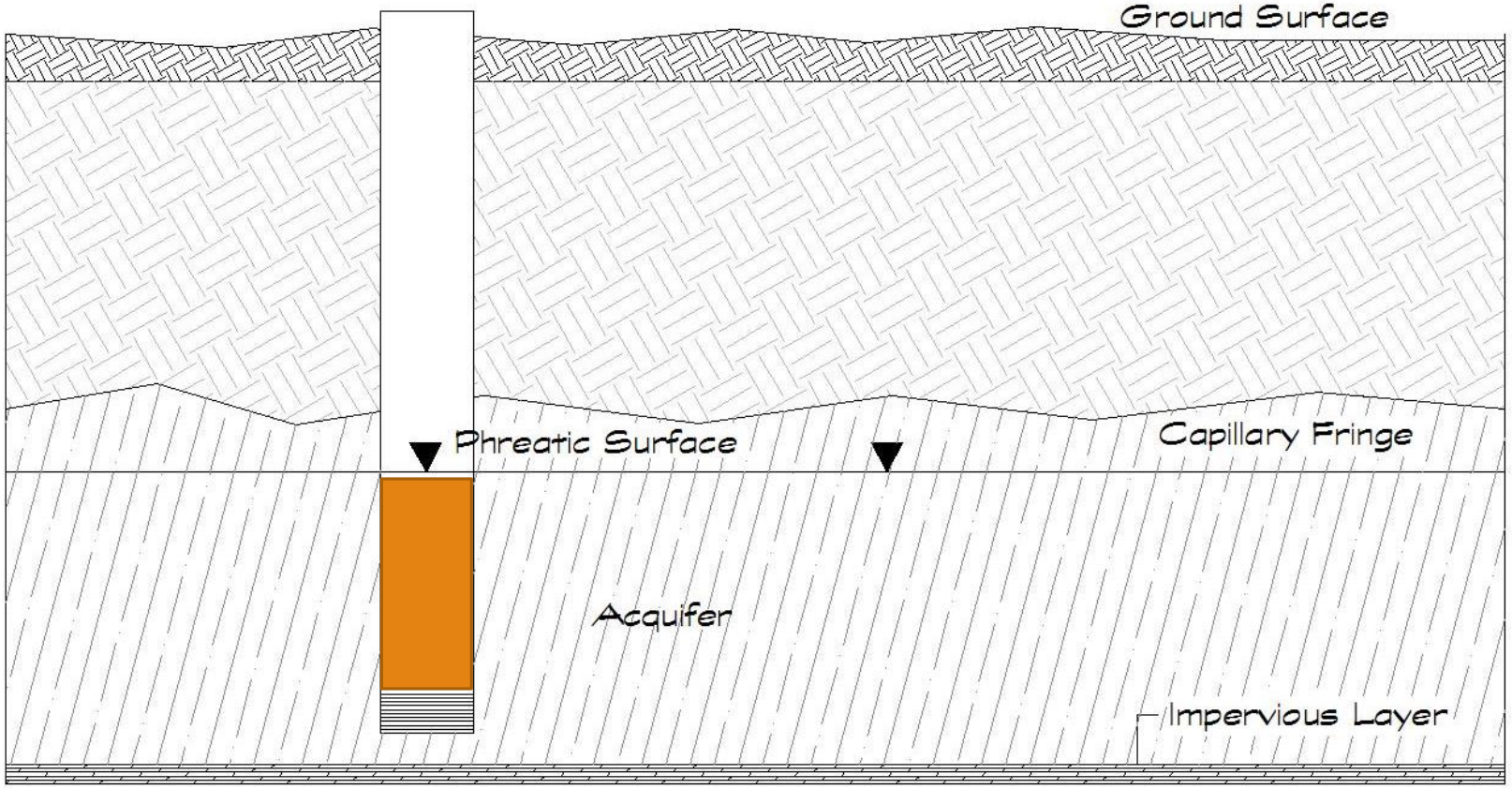
Figure 14. Lateral stresses due to wheel load

Concrete Pavement

Asphalt Concrete

Gravel Road

Hydrostatic loads…



Axisymmetric Loads

Radial stress. Symmetric to the axis of a manhole, can result from soil or water or a combination of both. …. Soil around aged structures has developed cohesion which can easily eliminate lateral pressure."

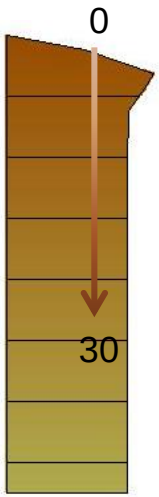
In Pitt's design example he concluded that a rehabilitation for the combined effects of traffic and maximum potential hydraulic head after seven days of curing would be as follows in his Table 8…

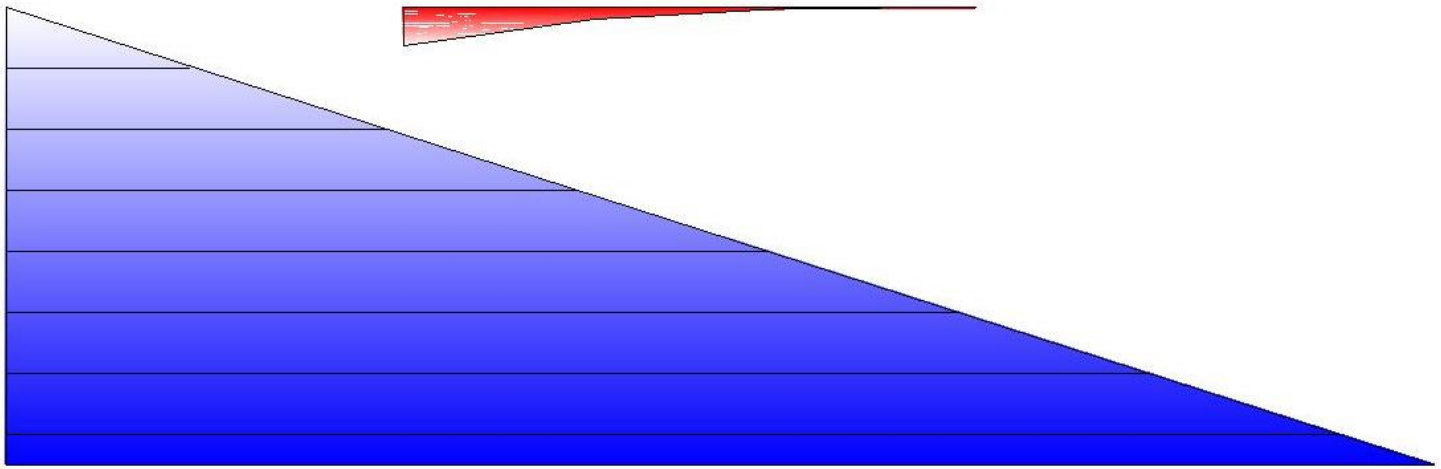
Thus rehabilitation for the combined effects of traffic and maximum potential hydraulic head after seven days of curing would be:

Depth, ft	Thickness, inches
0 -2	0.75
2 - 5	0.50
5 - 15	0.75
15 - 20	1.00

Table 8. Rehabilitation recommendations

Putting the loads together and into proper context…

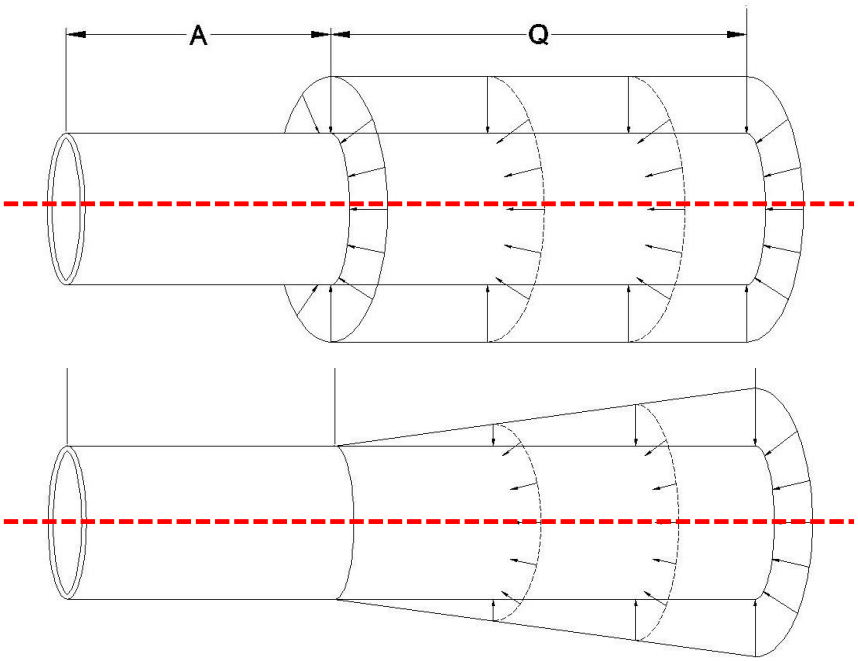




Soil

Hydrostatic

Can the ASTM F1216 Design Appendix be used?



Uniform loading condition of the ASTM F1216 Design Appendix…

Linearly increasing loading condition on a vertically-oriented cylindrical shaft…

Manhole Rehabilitation Design Steps

1. Assess the current condition on both the inside and outside of the manhole
    1. Type of construction
    2. Level of any wall loss
    3. Corrosive gases found within the manhole's environment
    4. pH of the wall surfaces
    5. Evidence of microbiological corrosion organisms
    6. Condition of the soil surrounding the manhole structure
    7. Observed infiltration through the wall
        1. Depth to the phreatic water surface
        2. Characterization of any observed water entering through the manhole wall
    8. Surface conditions
        1. Live load
        2. Type of pavement
2. Analyze the conditions found and define the needed performance parameters of the rehabilitation system(s) to be employed
    1. Design life requirements
    2. Service life expectations
3. Select the applicable rehabilitation solutions based on their estimated wall thickness and;
    1. Performance parameter requirements
    2. Cost of the applicable alternatives
        1. Design Life requirements
        2. Estimated Service Life of the alternative
    3. Selection of the most cost-effective rehabilitation solution(s)
4. Confirm the wall thickness parameters of the selected cost-effective alternative(s).
5. Establish the QA testing parameters to insure the design will be achieved in the field.

In conclusion…

Bonded liners do not warrant site specific wall thickness designs for routine installations…

	pH >7.0	3< pH<7	2<pH<3	pH ≤ 2	0<H<5'	5'<H<15'	H > 15'
CML – Type 1	Yes	Yes			0.50"	0.75"	1.00"
CACML	Yes	Yes	Yes		0.50"	0.75"	1.00"
CML+Epoxy	Yes	Yes	Yes	Yes	0.50/0.100	0.75/0.100	1.00/0.100

This concludes the education portion of this session.

Discussion and Q&A

Thank you!

William E Shook, AP/M Permaform
800-662-6465, bill@permaform.net

Norman E. (Ed) Kampbell, PE
Rehabilitation Resource Solutions, LLC

AP/M PERMAFORM
The trenchless solutions company