

August 18, 2020

Jeff Tinlin
 President
 Envirocort Technologies
 825 18th Street, Suite 200
 Vero Beach, FL 32960

RE: Poly-Triplex Manhole Rehabilitation Design

Dear Mr. Tinlin,

I reviewed design concepts applicable to manhole rehabilitation for the Poly-Triplex cured-in-place products. I found two different methods that could be used depending upon the initial condition of the manhole. The first, **Condition 1** type manholes, utilizes a hoop stress formula where compressive strength of the material is the applicable physical property. **Condition 1** manholes are considered structurally sound with no fracturing in concrete, no significant loss of bricks and inflow and infiltration are the main consideration. Secondly, **Condition 2** type manholes, utilize a design methodology from WRc practice, “*Structural Design of Type 1 Linings*,” found in volume III of the *WRc Sewerage Rehabilitation Manual* (1994). **Condition 2** type manholes exhibit deterioration, corrosion, cracking, voids, and missing components. Tensile strength is the applicable physical property used for this method.

I used the provided physical property values for each of the different liner types, 56-SL, 68-SL, and 116-SL and applied them to the design for Condition 1 and Condition 2 manholes. Below is a sample calculation for both Conditions. Refer to the attached charts for a summary of results.

Condition 1 Design Approach

The existing structure is fundamentally sound, some infiltration through joints, and no signs of deformation and or structural fatigue. Rehabilitation is primarily for Inflow and Infiltration abatement. For this design approach the compressive strength of the rehab material is the applicable physical property.

The Condition 1 Design Formula is:

$$t = \frac{(P_{hydro})(D)(FS)}{(144)(2)(C)}$$

Where;

t = thickness

P_{hydro} = (Manhole depth) (62.4lbs/ft³)

D = Diameter of manhole, in

FS = Factor of safety

C = Compressive strength of material, psi

Rearranging the formula to determine maximum depth rehab system can withstand;

$$\text{Manhole depth} = \frac{(t)(144)(2)(C)}{(D)(FS)(62.4\text{lbs/ft}^3)}$$

Provided compressive strength for 68-SL is 7,000psi. This liner has a minimum installed thickness of 140 mils. This example is for a 48in. diameter manhole

Therefore;

$$\text{Maximum Manhole Depth} = \frac{(.140\text{in}) (144) (2) (7,000\text{psi})}{(62.4\text{lbs/ft}^3) (48\text{in}) (2.5)} = 38 \text{ ft.}$$

The 68-SL series liner can be installed in a Condition 1 type 48 in. diameter manhole up to 38 feet deep and maintain a 2.5 Factor of Safety.

Condition II Design Method

The existing structure is deteriorated due to aging, corrosion, cracking, missing components, soil movement and soil loss. For this design approach the tensile strength of the rehab material is the applicable physical property.

Assumptions: Manhole Depth - 33 feet, Manhole located in light traffic road

P = Total vertical pressure, .204 N/mm² (29.58psi) extrapolated per attached chart.

K_s = Conjugate ratio of soil, 0.4 (Stable soil, large voids will be grouted, less than 10% deformation)

C = Bending moment coefficient, 0.3

T₂ = Thickness of existing structure, 4in.

T = Thickness of lining, .140in.

d = Diameter of existing structure, 48in.

s_t = Tensile strength = 13500 psi

T_d = Moment arm T_d = 0.67(4) + 0.5(.140) = 2.75in.

M = Bending moment = CPK_sd²/4 = (.3) (.204) (.4) (48)²/4 = 2044.6psi

F = Tensile force on lining = M/ T_d = 2044.6/2.75 = 743.5 in. lbs.

T = Product capacity = (s_t)(T) = (13500) (.140) = 1890 lbs

FS = Factor of safety = T/F = 1890/743.5 = **2.5**

The 68-SL series liner can be installed in a Condition 2 type 48 in. diameter manhole up to 33 feet deep and maintain a 2.5 Factor of Safety.

These design methods were used to calculate maximum depths for each Poly-Triplex Liner Series with different diameters.

Sincerely,



Tim Back, P.E.

