

# MONOFORM PLUS™

## SANITARY SEWER MANHOLE STRUCTURAL REHABILITATION WITH HDPE CONCRETE PROTECTIVE LINER

### PART 1 – GENERAL

#### 1.1.1 WORK INCLUDED

- A. The purpose of this specification is to provide a fully structural restoration of an existing concrete, brick or cement block constructed sanitary sewer manhole or wet-well structure. The restoration shall be accomplished by pouring a new structural monolithic concrete liner within the existing structure. By design, the new liner will have a minimum thickness of 4 inches in the barrel of the manhole and 5 inches in the chimney of the manhole. The concrete liner shall be installed with a High Density Polyethylene (HDPE) concrete protective liner (CPL), as required, in order to protect concrete surfaces from corrosion.

### PART 2 – PRODUCTS

#### 2.1 CONCRETE FORMS (MONOFORM FORMING SYSTEM)

- A. Specially designed Monoform Forming System forms are required to provide a rounded surface of the new concrete liner. Flat panels will not be accepted. The forming system shall be designed to fit the configuration of concentric structures and eccentric structures where applicable. The system shall be designed to allow the new concrete liner to be poured at a minimum of 4 inches thick.
- B. The system shall have straight sections in various diameters and rise heights and reducing sections to connect the various diameter straight sections.
- C. Block out inserts shall be used to provide full diameter opening to all piping entering and leaving the structure including active pipe connections above the bench elevation.
- D. The forming system (Monoform Forming System™) shall be that of Hydro-Klean, LLC of Des Moines, IA or approved equal.

#### 2.2 HDPE CONCRETE PROTECTIVE LINER

- A. The High Density Polyethylene (HDPE) concrete protective liner (CPL) shall be AGRU Ultra-Grip HDPE (high-density polyethylene). All HDPE liner sheets shall be extruded with a large number of anchoring studs, a minimum of 39 per SF (420/m<sup>2</sup>), manufactured during the extrusion process in one piece with the sheet so there is no welding and no mechanical finishing work to attach the studs to the sheet. The liner shall have a pull out of 16,500 psf. Minimum distance between studs shall be no less than 2.1275". Stud height shall be no less than 13mm or 9/16".

B. The HDPE CPL shall be designed and installed to protect concrete surfaces from corrosion.

Option 1: Flat liner sheet, non-anchored, used for overlapping joints, shall have a minimum thickness of 3 mm. All joints shall be sealed by means of thermal welding. Option II: Field install and weld a 90 degree liner turnback into the inside horizontal plane of the upper and lower construction joint, and sealed with ramnek, butyl or close cell rubber gasket, or approved equal.

C. When an interface is required to attach the HDPE liner to non-HDPE penetrations, use the polyester-backed HDPE sheet to provide a positive seal and transition between dissimilar pipe materials. Use a construction-grade two-part adhesive epoxy to attach the collar to the non-HDPE product.

D. The lining shall have good impact resistance, shall be flexible, and shall have an elongation sufficient to bridge up to a 1/4" settling crack, without damage to the lining. The liner shall be able to bridge any expansion cracks that may occur.

E. The lining shall be repairable at any time during the life of the structure.

F. The fabricator shall custom fit the HDPE CPL to the formwork to protect the new cast-in-place concrete surfaces from sewer gases and associated MIC. The interior surfaces to be protected shall include the bottom (bench & invert), cast-in-place walls, cast-in-place top, concentric reducers, chimney section, precast top slab, and pipe entries.

G. Penetrations for existing or new pipes may have an HDPE sleeve cast in the manhole wall. The HDPE wall sleeve shall be welded to the liner prior to casting. A flexible boot connector shall be installed inside of the HDPE wall sleeve. No further welding to this penetration will be required. Should the Contractor grout in the annular space inside the manhole for cosmetic reasons, then a field applied epoxy coating can be applied to cover the non-structural grout. The cast in sleeve will provide protection to keep any gas from getting behind the liner. For large pipe connections, the method of sealing the hole opening around the pipe will vary, as required by the resilient connector installation guidelines provided by the manufacturer. Pipe to manhole connectors must meet the requirements of ASTM C-923. The manufacturer will determine the best method to provide a gas tight seal between the connector and the inside wall of the structure.

H. Physical Properties.

1. The AGRU CPL systems and welding rod shall be manufactured from the same resins and meet the following properties.

PRODUCT DATA				
Property	Test Method	Minimum Average Values		
Thickness (nominal), mil (mm)	ASTM D5199	80 (2.0)	120 (3.0)	200 (5.0)
Density, g/cc, minimum (black)	ASTM D792, Method B	0.94	0.94	0.94
Density, g/cc, minimum (yellow/other)		0.935	0.935	0.935
Tensile Properties (ave. both directions) Strength @ Yield (min. ave.), lb/in width (N/mm)	STM D6693, TYPE IV 2 in/minute	176 (30.8)	264 (46)	440 (77)
Elongation @ Break (min. ave.), %(GL=2.0in)		300	300	300
Carbon Black Content (range in %)**	ASTM D4218	Only near spherical agglomerates For 10 views; 9 views in Cat. 1 or 2, and 1 view in Cat. 3		
Pull Out Resistance psf (kN/m <sup>2</sup> )	ISO 4624	16,500 (800)		
Back Pressure Resistance long term	SKZ-Test 700mm x 700mm	1000 hour at 1.5 bar (21.76 psi)		

\*\* - AGRU America geomembranes are certified to pass Low Temp. Brittleness via ASTM D746 (-80° C) and Dimensional Stability via ASTM D1204 ( ±2% @ 100° C

2. Upon request, the manufacturer shall provide written certification that the liner used meets or exceeds the requirements of this specification.

### **2.3 HIGH-STRENGTH FIBER REINFORCED CONCRETE (MONOLITHIC CONCRETE LINER)**

- A. Concrete materials shall be selected and proportioned in such a manner as to produce concrete which will be extremely strong, dense, and resistant to weathering and abrasion.
- B. A collated, fibrillated polypropylene (fiber mesh or equal) admixture shall be added according to the admixture manufacturer's recommendations.
- C. Concrete shall have a minimum 28-day cure strength of 4,500 psi.
- D. Concrete shall conform to the following ASTM standards: C-33; C-94; C-150; C-260; and C-494.

## **PART 3 – EXECUTION**

### **3.1 PREPARATION**

- A. Remove all debris, grease, and loose material from the structure's surface. All existing steps shall be removed to within 1 inch of the existing wall. Remove the existing casting and the chimney section and/or top slab over the existing manhole so that the chimney is opened to a 36" rough opening. After the existing chimney is removed, a 36 inch inside diameter form is to be used as an outside pouring form. This form can be a typical pour tube (Sono-tube) which remains in place following construction. A removable form is also acceptable. In no

instances will the liner be allowed to be poured in the excavation without the use of a form to provide a break between the unexcavated earth and the newly constructed liner.

- B. Removed material will not be allowed to enter the pipeline. All dislodged material will be removed from the structure and disposed of by the Contractor. The owner will provide a dumpsite for the Contractor to dispose of debris.
- C. Any castings that are not being reused shall be salvaged and delivered to a location provided by the Owner.

### **3.2 FORMING**

- A. Place the Monoform Forming System, including barrel sections, concentric reducer, eccentric reducer and/or flat-top reducer forms on the inside of the manhole or structure.
- B. Install chimney forms, as needed.
- C. Install prefabricated and/or field fabricated HDPE protective liner sections onto the Monoform Forming System.
- D. Follow the Guide to Formwork for Concrete (ACI 347R-14).

### **3.3 INSTALLATION OF HIGH-STRENGTH FIBER REINFORCED MONOLITHIC CONCRETE LINER**

- A. The new high-strength fiber reinforced monolithic concrete liner shall be installed without disruption of flow at the bench level of the manhole. Whenever possible, flows entering the structure above the bench level shall be handled by means of a flow through line plug and piping plumbed through the forming system passing flow into the outlet invert.
- B. In instances where the pour depth is less than 15 vertical feet, the entire liner shall be installed in one pour without joints. If the pour depth exceeds 15 vertical feet, the new liner shall be poured in stages. A water stop shall be installed to ensure a watertight seam is obtained between subsequent pours.

### **3.4 POURING OF CONCRETE**

- A. Concrete shall be thoroughly consolidated so that it comes into close contact with the forms and fills all existing pockets, seams, and cracks. Consolidation shall not be continued so as to cause segregation, or to the extent that localized areas of grout are formed. The operations of pouring and consolidating shall be so conducted that the resultant concrete, upon removal of the forms, is smooth and dense, free from any honeycomb or pockets of segregated aggregate.
- B. Cure concrete according to Specification for Curing Concrete (ACI 308.1-11).

### **3.5 BENCH AND INVERT REPAIR OR REPLACEMENT**

- A. All manholes to be reconstructed will require bench and/or invert repair or replacement. The engineer will determine the extent of work needed at each manhole and notify the contractor prior to commencing the work.
- C. Preparation. Whenever possible, bypass plugs will be installed in all the inlets and plumbed into the outlet, allowing flow to pass through the structure without interference of bench and invert repairs. All loose and/or deteriorated material shall be removed. Material will be removed to allow a minimum of 2 inches of new concrete to be placed around the circumference of the invert and over the existing bench at a point half the depth of the outlet invert and tapered up to the wall.
- D. Forming New Inverts. A forming system shall be used to provide a smooth, straight, and uniform flow line from the invert of the inlet pipe(s) to the invert of the outlet pipe. Where laterals are present, the system shall provide for a sanitary sweep into the main flow line.
- E. Installation. New concrete shall be placed to a minimum 2 inch thickness, over solid existing concrete base properly prepared as specified for manhole walls. Where solid concrete does not remain after preparation, new concrete shall be poured to a minimum 4 inch thickness. The new bench shall be tapered up to the manhole wall at a slope of 2 inches per foot.

### **3.6 CASTINGS, FRAMES, COVERS, GRADE RINGS**

- A. Provide and install one 2 inch (36" O.D. by 26" I.D.) grade ring. Grade rings shall be Part Number \_\_\_\_\_ as manufactured by \_\_\_\_\_. The ring shall be set in a fresh bed of mortar, extending the full width of and continuously around the ring. The mortar shall be Type "M" mortar, meeting the property specification of ASTM C-270. Provide and install new castings for all rehabilitated manholes.
- B. Provide and install new chimney seals for each reconstructed manhole. Castings shall be shall be Type \_\_\_\_\_ as manufactured by \_\_\_\_\_ with self-sealing gasketed cover (City Standard). Chimney seals shall be the Infishield 36x12 external seal as manufactured by Sealing Systems, Inc. All costs related to the installation of new castings, grade rings and chimney seals shall be included in the "Manhole Rehabilitation, Concrete Liner, Complete."

### **3.7 SURFACE RESTORATION**

- A. The contractor shall be responsible for restoring the street pavement, including saw-cutting and removing existing pavement, supplying and placing  $\frac{3}{4}$ " base material, and supplying and placing a concrete pavement surface at a minimum thickness of 9 inches. Particular attention shall be made toward orienting the "diamond" cut points to be centered and

parallel with existing street or intersection. Control joints shall be saw-cut or troweled to a uniform depth of 1/8". Backfill surface excavation with granular material and compact the excavation after the concrete liner has sufficiently cured.

- B. Place new concrete at a minimum thickness of 9 inches with No. 4 rebar centered within slab. Concrete shall have a 28 day cure strength of 6500 psi.

### **3.8 WELDING OF HDPE PROTECTIVE LINER**

- A. Inspect the HDPE Concrete Protective Liner after removal of forms and repair all anomalies in the structure.
- B. Weld all joints and/or seams in the HDPE Concrete Protective Liner.
- C. All welding shall be performed in accordance with the published directives and procedures of the manufacturer and by welders certified as trained by the manufacturer. Completion of welding will provide a one piece monolithic concrete protective liner system that will provide excellent resistance to hydrogen sulfide attack and will not pull off the wall in the event that infiltration occurs.
- D. The following welding techniques are acceptable:
  - a. Extrusion Welding: Used to seal all seams inside structure, primary welding method.
  - b. Butt Welding: Used to fuse flat sheets together.
  - c. Hot Air Welding: Used as a tack weld or only in triple pass method where extrusion welding is not possible.
- E. Testing and supervision of the installation and welding shall be performed by qualified staff only and must be checked when completed by visually checking and by Spark Testing all welded joints.
- F. Sample welds are to be taken weekly at minimum and submitted to the quality assurance department for testing. The following tests are performed: Shear and Peel Test. Shear weld test results shall meet or exceed at least 80% strength of parent material in a destructive test, which pulls the sample apart to test the strength and integrity of the extrusion weld. The peel test pulls the weld apart from the backside of the weld using a peeling type motion. The results of this test shall meet or exceed 70% of the value of the parent material.

### **3.9 PAYMENT**

- A. All costs related to manhole rehabilitation, including cleaning, step removal, interior preparation, removal of chimney sections, salvaging existing castings, flow management, disposal of waste materials, structural concrete liner installation, bench and invert repair or replacement, protective HDPE liner installation, HDPE liner welding, spark testing, new castings, adjustment rings, internal/external chimney seals and pavement restorations shall be included in the unit price bid for "SANITARY SEWER MANHOLE STRUCTURAL REHABILITATION WITH HDPE CONCRETE PROTECTIVE LINER, COMPLETE"

END OF SECTION