7-0 SANITARY SEWER SYSTEMS

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7-1 OVERVIEW OF SANITARY SEWER SYSTEMS

Construction of new sanitary sewer systems, as well as the separation of older combined sewers due to environmental concerns, is a necessity for community development and growth. Being essential to public health and overall welfare, sanitary sewers serve to collect and transport domestic, commercial and industrial wastewaters to a facility for treatment and disposal. For existing combined storm and sanitary sewers, a community's investment in a dedicated sanitary sewer will aid environmental protection as well as exclude storm water from the costly treatment processes.

There are a number of design considerations, including corrosion resistance, structural strength, hydraulic characteristics, and overall service life, that influence the selection of a pipe material. Finding a balance between annual service costs and the system's functionality and durability over the service life is a critical decision when making such a large monetary community investment.

7-2 SANITARY SEWER PROJECTS

A sanitary sewer project can be categorized into four main stages of development: preliminary investigation, design, construction and operation. The following briefly describes each stage of development and its impact on the project.

PRELIMINARY INVESTIGATION

One the most critical stages of sewer development is the planning stage. Inadequate preliminary and investigative work may adversely affect the design or construction, compromising the successful completion of the system in a timely and economical manner. Both the engineer and owner must work together during this developmental stage, though all policy and financial decisions remain exclusively with the owner.

An engineering report is typically submitted once all preliminary work is done. Included in the engineering report will be a review of existing conditions as well as proposed methods and generic layouts that will meet the project's goals. While information tends to be relatively broad during this stage, some specificity is necessary in order to establish construction and operation cost estimates. Without preliminary sizing, design data, financial planning, feasibility and the overall consideration of all alternatives this stage cannot be adequately completed.

DESIGN CONSIDERATIONS

The design phase includes the preparation of the construction documents by the design engineer. Plans and specifications will provide contractors, distributors and vendors with information necessary for bid proposal and determining suitable products. The owner will continue to provide input and information as needed to ensure the project meets the community's needs, as well as review any alternatives that are presented by the engineer.

Sanitary sewer system design has two primary considerations: the design period for which the sanitary sewer will meet capacity requirements and the design flow expected over the design period.

The design period for most sanitary trunk lines and interceptors is 50-years. More rural or undeveloped areas may limit the development period. The design period is also based on past and future water use, population trends and current usage statistics.

The design flow is simply the quantity of water that will be conveyed through the system. The determination of the design flow rate is primarily dependent on the population served, population density, and water consumption. In some communities however, inflow from non-wastewater sources, like roof and foundation drains, may also be included in the peak design flow. It follows intuition that construction costs associated with sanitary sewers conveying both wastewater and non-wastewater will be higher than costs of sanitary sewers in communities that prohibit non-wastewater connections. Ascertaining the peak design flow for a specific community will be influenced by past usage, topography and political considerations, all of which will vary regionally.

CONSTRUCTION

Once all plans have been finalized and approved by the owner, the contactor assumes the liability of building the project per the drawings and specifications. During this stage, the engineer often becomes a representative of the owner, ensuring all work is done in accordance with the contract documents. The engineer will review any submittals from the contractor for proposed products or installation procedures as well as troubleshoot any issues that may arise from errors in the construction documents or if site conditions vary from the construction documents, thereby affecting the anticipated progress of work.

OPERATION

Upon completion of construction, the owner will accept the system and take final responsibility for operation and maintenance. The engineer will provide all necessary operation and maintenance information to the owner for the proper function of all parts of the system. In some cases, the engineer or an outside consulting or maintenance company may be contracted to assist with the operation of the system.

7-3 ADS SANITITE® HP PIPE

The overall efficiency of a sanitary sewer system depends on a balance of the initial construction costs and the long-term performance of the system. Lower initial construction costs with poor materials may result in high long-term maintenance costs, or even replacement before the design period expires if serious issues arise.

However, high initial construction costs may put excessive burdens on the community which can adversely affect future development.

To aid the designer in selecting a pipe material that will be suitable for the specific project, the following provides design information specific to ADS SaniTite HP pipe:

PIPE DESIGN

The SaniTite HP product is made from polypropylene resin which is analogous to combining the durability of high density polyethylene (HDPE), and the stiffness of poly-vinyl chloride (PVC) but with improved impact resistance and less susceptibility to brittleness. SaniTite HP pipe is available in 12- through 60-inch (300 to 1500mm) diameters. Polypropylene products can be distinguished from other ADS pipe products by its light grey color.

ADS SaniTite HP pipe uses the state-of-the-art design that incorporates profile wall geometry for structural strength and a smooth inner wall for hydraulic capacity. The 12- through 24- inch (300 – 600mm) pipe has a corrugated exterior while the 36- through 60-inch (900-1500mm) diameter pipe incorporate an exterior shell over the corrugations. The 30-inch (750mm) pipe can have a corrugated exterior or an exterior shell over the corrugations. The smooth inner wall combines superior hydraulics with the ability to resist abrasion and corrosion. The corrugated wall provides the strength necessary to withstand live loads associated with heavy traffic and dead loads associated with deep burials. The outer shell on large diameter pipe provides added stiffness and beam strength.

BELL & SPIGOT JOINT

The SaniTite HP joint features an extended bell-and-spigot joint that promotes faster, easier installation along with increased joint performance from the presence of two gaskets and a reinforced bell with a polymer composite band. This joining method ensures joint alignment, improves joint reliability, and eliminates the need for glue or secondary joining operations. Joints provide a watertight level of performance meeting the laboratory requirements set in ASTM D3212 with the exception of an increased pressure of 15psi (100 kPa) with zero leakage. In field applications, SaniTite HP pipe may be tested with an allowable leakage rate in accordance with ASTM F2487 or F1417. SaniTite HP pipe is intended for non-pressure, gravity flow sanitary sewers.

FITTINGS

A large selection of fittings are available for SaniTite HP pipe, including tees and reducing tees, wyes and reducing wyes, and as well as reducers. Custom fabricated fittings may also be available and will be evaluated based on the application conditions. Fabricated fittings with an excess of 8-ft (2.4m) of cover should be reviewed by the Engineering Services Department.

STRUCTURAL DESIGN

For evaluating SaniTite HP pipe's structural performance, the American Association of State Highway Transportation Officials (AASHTO) Load Resistance and Factor Design (LRFD) method for thermoplastic pipe is used. An explanation of the design method, including pipe dimensional properties required for design, is available in Section 2: *Structures* of this handbook. A maximum cover height table, based on the backfill material and compaction level, for SaniTite HP is also available in Technical Note 2.05: *Minimum and Maximum Cover Heights for SaniTite HP*, included in this manual.

HYDRAULIC CHARACTERISTICS

Based on site requirements, the design engineer will determine if the sewer will be gravity-flow or a force main. ADS sanitary sewer products are only intended for gravity-flow conditions. The design Manning's "n" value for SaniTite HP is 0.012. Flow capacity charts may be found in Section 3: *Hydraulics* section of this handbook.

DURABILITY CHARACTERISTICS

Another critical consideration during pipe material selection is its durability in the corrosive environment typically found in sanitary systems. Some designs are able to limit the concentration of corrosive chemicals in the system through regular maintenance or point-source control but their presence altogether is typically unavoidable. SaniTite HP pipe is made from chemically inert and highly durable polypropylene material which is unaffected by most common sanitary sewer chemicals including hydrogen sulfide. Additional information on the durability of the product is available in Section 4: *Durability* of this handbook. Chemical resistance tables for both polypropylene and available gasket materials for the joint are available in Technical Note 4.02: *Chemical Resistance of Polypropylene and Elastomers*, included in this handbook.

7-4 INSTALLATION CONSIDERATIONS

Standard installation recommendations for all ADS pipe products are provided in Section 5: *Installation* of the Drainage Handbook. Installation recommendations specific to ADS SaniTite HP pipe based on the minimum or maximum fill height over the pipe are provided in Technical Note 2.05: *Minimum and Maximum Cover Heights for SaniTite HP Pipe.*

The selection of a suitable pipe product will also be dependent on any special installation requirements for the system. The need for additional fittings, structures or installation measures may increase anticipated costs. The following addresses some common considerations along with recommendations for the proper use of SaniTite HP pipe.

MANHOLE AND STRUCTURE CONNECTIONS

Quite often, manhole connections will need to be watertight. Since concrete does not readily adhere to thermoplastic material, a compression gasket or boot connection will need to be used.

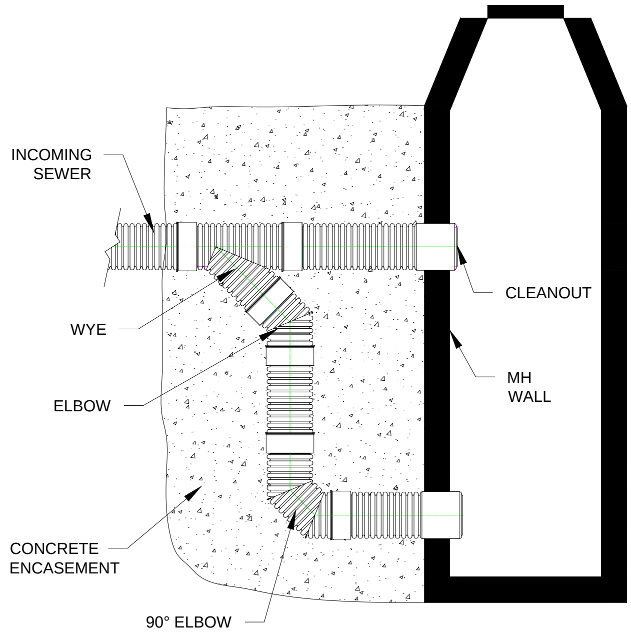
The use of flexible manhole connections will allow for some flexure at the connection if some differential settlement occurs, but care should still be taken to properly backfill and compact underneath the pipe at the manhole to avoid shearing forces that may damage the pipe. Using a short section of pipe, 3- to 6-ft (0.9-1.8m) long will also help minimize affects of manhole settlement.

The outside diameter and profile of the pipe connecting to the structure are critical for selecting the correct manhole gasket or boot. Standard details are available that provide the pipe or fitting's outside diameter, as well as the part number of the respective manhole compression gasket or boot connection that are supplied by other manufacturers. Please contact your local sales representative for this information.

DROP MANHOLES

For areas in the system where there is a significant change in grade or elevation due to topography, a drop manhole may be used. Due to space constrictions within the manhole and to avoid the increased costs of larger manholes, outside drop structures are typically used. To prevent pipe settlement when placed vertically, the entire section should be encased in concrete to ensure adequate support of the pipe. Figure 7-1 shows a typical outside drop manhole installation. Based on diameter, a standard tee or wye fitting may be used to transition to the lower section of the drop connection.

Figure 7-1
Typical Outside Drop Manhole

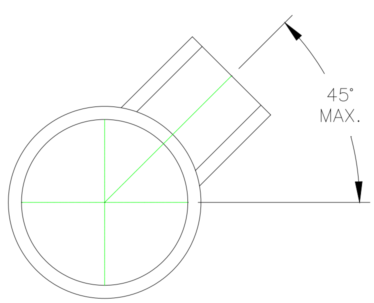


SERVICE CONNECTIONS & LATERALS

Sanitary sewer systems may require changing pipe materials, sizes, elevation, or direction. Local regulations may require using a manhole or structure to make these transitions but other options such as fittings or adapters specifically designed for this application may also be acceptable. Verify local requirements prior to ordering fittings, adaptors, and other accessories and components.

If using an Inserta-Tee®, Fernco® QwikSeal™, or other field tap connection, the stub portion should not be placed at an angle greater than 45-degrees from horizontal. Stubs that must be oriented at an angle greater than 45-degrees from horizontal may require flowable fill or concrete backfill to prevent settlement into the mainline pipe.

Figure 7-2
Stub Orientation for Field Connections



HORIZONTAL CURVES

To improve hydraulics or as a cost saving measure to reduce manholes, pipe lines may have gradual curves. A radius of curvature can be achieved by laying straight sections of pipe and only deflecting the joint. In order to maintain joint performance, joint articulation should not exceed 3-degrees. Depending on project requirements, fittings may also be used to create gradual transitions along the pipeline. It is imperative the pipe itself shall never be bent or deflected in order to create a radius.

CASINGS

Installations that must avoid disturbing the ground surface, whether under a heavily travelled or protected area, or where high impact surface loads are expected, will require the use of a casing pipe. ADS products are not to be used during the jacking or boring operations and should only be installed in a casing pipe that can withstand the installation operations and final loading conditions. Other circumstances requiring the use of a casing pipe include river crossings, pipe crossings in close proximity, or high groundwater pressures.

In contrast to sliplining installations where existing pipe is deteriorated or failing, the casing pipe is installed shortly before the placement of the sewer pipe. A horizontal bore is created using a rotating auger within a steel casing. The casing used during boring may be left as the final casing pipe or a different casing pipe is installed once boring operations are complete.

The outside diameter of the sewer pipe and the inside diameter of the casing pipe should be compared to ensure there is adequate space for work procedures. Manufactured casing spacers or skids should be secured to the sewer pipe in order to safely insert the pipe into the casing pipe. Constant longitudinal support of the pipe is needed to maintain a constant grade. Where full longitudinal support cannot be achieved using spacers or skids, grout may be used to provide support of the pipe and prevent flotation. For more detailed recommendations related to installing pipe through casings, refer to Technical Note 5.18 Lining of Casings with SaniTite HP Pipe

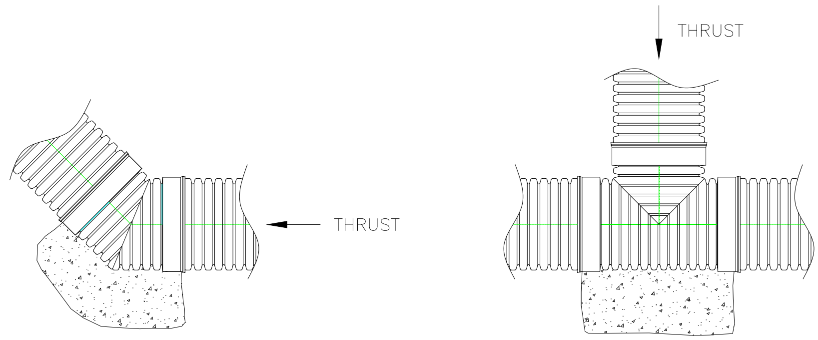
THRUST RESTRAINT

For gravity-flow systems additional measures may still be required to prevent joint separation. Most commonly, a change in flow direction or the presence of a soil with inadequate bearing strength to withstand the load will necessitate some form of thrust restraint. Line connections with a tee, directional changes with a bend and where the pipeline size changes are common transitions where additional restraint may be required.

Cast in place concrete thrust blocks are the most common preventative measure taken. A generic example is shown in Figure 7-3. A thrust block should not encase the entire joint;

otherwise flexibility of the joint will be limited. Concrete shall also be poured against undisturbed earth to minimize soil consolidation.

Figure 7-3
Cast In Place Thrust Block Placement



Precast concrete blocks may also be used, but should not be placed directly against the pipe to avoid point loads on the fitting. Backfill should be placed between the face of the precast block and the fitting in order to provide uniform support of the fitting.

The design of a thrust block is a function of the thrust force and the load-bearing capacity of the soil. For gravity-flow systems, the thrust force will vary based on the effluent velocity and pipe diameter. When soil conditions are unknown, soil samples should be collected and tested in order to determine the soil type. Engineering reference manuals will provide typical soil bearing capacities based on soil type. Burial depth can also be considered when determining soil bearing capacity, where shallow (less than 3-ft [0.9m]) installations will lower the soil's bearing capacity.

GROUNDWATER

The maximum cover heights listed in Technical Note 2.05: *Minimum and Maximum Cover Heights for SaniTite HP Pipe* do not account for hydrostatic pressure due to groundwater. ADS Applications Engineering can assist in determining the pipe's structural performance in accordance for LRFD Section 12 for projects where the published assumptions are exceeded.

POST-INSTALLATION TESTING

Post-installation testing is commonplace for most sanitary sewer installations. Thermoplastic pipes are tested for either joint integrity or deflection, or both.

Joint integrity is tested by either pressurizing a run of pipe to determine the leakage rate or by isolating a specific number of joints and pressurizing only the joint to determine the leakage rate. The project's acceptable leakage rate will be a function of the test pressure and test duration. Performance testing will use either air or water to pressurize the void space in the pipe run or joint area. Refer to the *Installation* section of the Drainage Handbook for additional information on infiltration/exfiltration and air testing.

For SaniTite HP, ASTM F2487 is recommended for infiltration/exfiltration testing, with a leakage rate of 50 gal/inch-diameter/mile-pipe/day. ASTM F1417 is recommended for air testing. Caution should be exercised to ensure any testing is done safely. While an allowable leakage rate of 200 gal/in-diam/mile-pipe/day is a common industry standard, regional leakage rates should be consulted for the specific project.

Deflection testing of thermoplastic pipe provides a relatively quick indicator of how well the backfill was placed around the pipe within days of the installation. A deflection of 7.5% after 30 days is a commonly accepted limit. Although the allowable deflection limit is ultimately up to the design engineer, it should always be based on a prescribed period of time, typically 30 days. Determining the allowable inside diameter of the tested pipe is often stated in the projects written specification but may also be based on the pipe's initial base inside diameter. For more information on deflection testing methods and base diameter values of ADS pipe for deflection limits, refer to Technical Note 5.17: *Post-Installation Testing for SaniTite HP*, included in this manual.

7-5 REFERENCES

Gravity Sanitary Sewer Design and Construction (ASCE Manuals and Reports on Engineering Practice No. 60) (WPCF Manual of Practice No. FD-5). (1982). Virginia: American Society of Civil Engineers and Water Pollution Control Federation.

7-6 OTHER TECHNICAL RESOURCES

ADS Technical Notes

Technical Note 2.05: *Minimum and Maximum Cover Heights for SaniTite HP Pipe*

Technical Note 4.02: *Chemical Resistance of Polypropylene and Elastomers*

Technical Note 4.03: *Abrasion Resistance of Polypropylene*

Technical Note 5.01: *Recommended Use for Trench Boxes*

Technical Note 5.02: *Flowable Fill Backfill for Thermoplastic Pipe*

Technical Note 5.05: *Pipe Flotation*

Technical Note 5.13: *SaniTite HP Pipe Repair Options*

Technical Note 5.14: Culvert *Sliplining with HP Pipe*

Technical Note 5.15: *Integral Bell Transition for HP Pipe*

Technical Note 5.16: *Sealing Methods for Vent Tubes*

Technical Note 5.17: *Post-Installation Testing of HP Pipe*

Technical Note 5.18: Lining of Casings with SaniTite HP Pipe

<u>ADS Standard Details</u>

Standard Detail 101F: Trench Installation Detail (SaniTite HP)

Standard Detail 205A through 205G: *SaniTite HP Manhole Connections*

Standard Detail 408 through 410: SaniTitie *HP Tee Base Details*