**Section 370.320 Details of Design and Construction**

a) Minimum Size

No public gravity sewer conveying raw sewage shall be less than 8 inches in diameter.

b) Depth

Sewers shall be sufficiently deep to prevent freezing. Sewers should be sufficiently deep to serve basements except where overhead sewers are required by local ordinances or will be provided.

1) Minimum Cover

The minimum cover of sewers shall be no less than 3 feet unless special structural protection is provided.

2) Buoyancy

Where high ground water conditions are anticipated, buoyancy of sewers shall be considered and, if necessary, adequate provisions should be made for protection.

c) Slope

1) All sewers shall be designed and constructed to give mean velocities, when flowing full, of not less than 2.0 feet per second, based on Manning's formula using an "n" value of 0.013. The following minimum slopes shall be provided; however, slopes greater than these are desirable:

|  |  |  |
| --- | --- | --- |
| Slope in Feet |  |  |
|  |  |  |
| Sewer Size | Per 100 Feet | Flow (mgd) |
|  |  |  |
| 8 inch | 0.40 | 0.49 |
| 10 inch | 0.28 | 0.75 |
| 12 inch | 0.22 | 1.07 |
| 14 inch | 0.17 | 1.43 |
| 15 inch | 0.15 | 1.61 |
| 16 inch | 0.14 | 1.85 |
| 18 inch | 0.12 | 2.35 |
| 21 inch | 0.10 | 3.23 |
| 24 inch | 0.08 | 4.13 |
| 27 inch | 0.067 | 5.17 |
| 30 inch | 0.058 | 6.37 |
| 33 inch | 0.050 | 7.66 |
| 36 inch | 0.046 | 9.23 |
| 42 inch | 0.036 | 12.41 |

2) Under special conditions, if detailed justifiable reasons are given, slopes slightly less than those required for the 2.0 feet per second velocity when flowing full may be permitted. Such decreased slopes will only be considered where the depth of flow will be 0.3 of the diameter or greater for design average flow. Whenever such decreased slopes are selected, the design engineer must furnish with his report his computations of the depths of flow in such pipes at minimum, design average, and design peak rates of flow. It must be recognized that decreased slopes may cause additional sewer maintenance expense and special linings or materials should be considered for corrosion protection.

3) Uniform Slope

Sewers shall be laid with uniform slope between manholes.

4) Steep Slope Protection

Sewers on 20 percent slope or greater shall be anchored securely with concrete anchors or equal, spaced as follows:

A) Not over 36 feet center to center on grades 20 percent and up to 35 percent.

B) Not over 24 feet center to center on grades 35 percent and up to 50 percent.

C) Not over 16 feet center to center on grades 50 percent and over.

d) Alignments

1) Straight Alignments

Except as noted in subsection (d)(2), all sewers shall be laid with straight alignments between manholes.

2) Curvilinear Alignments

Curvilinear sewers are permitted in special cases provided the following minimum requirements are met:

A) Curvilinear Sewers 24 Inches in Diameter and Smaller

i) Location: Curvilinear alignments should follow the general alignment of streets.

ii) Type Curve: Only simple curve design is acceptable.

iii) Radius of Curvature: The minimum allowable radius of curvature is 300 feet.

iv) Manholes: Manholes are required at the beginning and end of all curves.

v) Joints: Compression joints are required. The ASTM or AWWA maximum allowable deflection of the pipe joints shall not be exceeded.

vi) Velocity: In order to maintain a minimum velocity of 2 feet per second in curvilinear sewers, hydraulics of the curvilinear alignment shall be taken into account and the minimum slopes indicated in subsection (c)(1) must be increased accordingly.

B) Curvilinear Sewers 24 Inches Through 48 Inches in Diameter

Curvilinear sewers larger than 24 inches in diameter up to 48 inches in diameter constructed with pressure pipe meeting AWWA standards may be used. Other curvilinear sewers larger than 24 inches in diameter up to 48 inches in diameter shall meet the requirements of subsection (d)(2)(A) except that the joints must be manufactured so that they fit together squarely without deflection at the design curvature and the radius of curvature may be less than 300 feet.

C) Curvilinear Sewers Larger Than 48 Inches in Diameter

Curvilinear sewers larger than 48 inches in diameter shall be provided with square fitting compression joints and shall meet the requirements of subsection (d)(2)(A)(vi). The remaining design requirements under subsection (d)(2)(A) for these sewers will be reviewed by the Agency on a case by case basis.

e) Increasing Size

When a smaller sewer joins a larger one, the invert of the larger sewer should be sufficiently lower to maintain the energy gradient. An approximate method for securing these results is to place the 0.8 depth point of both sewers at the same elevation.

f) High Velocity Protection

Where velocities greater than 15 feet per second are attained, the special provisions described in subsection (c)(4) shall be made to protect against displacement by erosion and shock.

g) Materials and Installation

1) Materials

A) Any generally accepted material for sewers will be given consideration, but the material selected should be suitable for local conditions, such as character of industrial wastes, possibility of septicity, soil characteristics, exceptionally heavy external loadings, abrasion, structural considerations and similar problems.

B) All sewers shall be designed and installed to prevent damage from superimposed loads. Proper allowance for loads on the sewer shall be made because of the width and depth of trench. When the bearing strength of the pipe is not adequate to withstand the superimposed loading, other pipe material, special handling, concrete cradle or special construction shall be used.

C) For new pipe materials for which ASTM standards have not been established (see subsection (g)(2)), the designing engineer shall provide complete installation specifications developed on the basis of criteria adequately documented and certified in writing by the pipe manufacturer to be satisfactory for the design conditions for the specific project. Such documentation and manufacturers' certification shall be submitted as a part of the project plan documents.

2) Installation

A) Standards

i) Installation specifications shall contain appropriate requirements based on the criteria, standards and requirements established by ASTM. Requirements shall be set forth in the specifications for the pipe and methods of bedding and backfilling thereof so as not to damage the pipe or its joints, impede cleaning operations and future tapping, nor create excessive side fill pressures or ovalation of the pipe, nor seriously impair flow capacity.

ii) For new pipe material, the installation specifications shall meet the provisions of subsection (g)(1).

B) Trenching

i) The width of the trench shall be ample to allow the pipe to be laid and jointed properly and to allow the backfill to be placed and compacted as needed. The trench sides shall be kept as nearly vertical as possible. When wider trenches are dug, appropriate bedding class and pipe strength shall be used.

ii) Ledge rock, boulders, and large stones shall be removed to provide a minimum clearance of 4 inches below and on each side of all pipe and joints.

C) Bedding

i) Bedding classes A, B, or C, as described in ASTM Cl2-95, "Standard Practice for Installing Vitrified Clay Pipe Lines" (1996) or "Standard Specifications for Water and Sewer Main Construction in Illinois", 5th ed. (1996) (no later additions or amendments) or WPCF Manual of Practice (MOP) No. FD-5 (1982) (no later additions or amendments) shall be used for all rigid pipe provided the proper strength pipe is used with the specified bedding to support the anticipated load.

ii) Bedding class I, II, or III, as described in ASTM D2321-89, "Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications" (1996) (no later editions or amendments) or Standard Specifications for Water and Sewer Main Construction in Illinois, 5th ed. (1996) (no later additions or amendments), or WPCF MOP No. FD-5 (1982)(no later additions or amendments) shall be used for all flexible pipe provided the proper strength pipe is used with the specified bedding to support the anticipated load.

D) Backfill

i) Backfill shall be of a suitable material removed from excavation except where other material is specified. Debris, frozen material, large clods or stones, organic matter, or other unstable materials shall not be used for backfill within 2 feet of the top of the pipe.

ii) Backfill shall be placed in such a manner as not to disturb the alignment of the pipe.

iii) For flexible pipe, as a minimum, backfill material shall be placed and carefully compacted in accordance with ASTM D2321-89 (1996) to provide the necessary support for the pipe.

3) Deflection Testing of Flexible Pipe.

A) The design specifications shall provide that the first 1200 feet of sewer and at least 10% of the remainder of the sewer project shall be deflection tested. The entire length of a sewer of less than 1200 feet shall be deflection tested.

B) If the deflection test is to be run using a rigid ball or mandrel, it shall have a diameter equal to 95% of the inside or base diameter of the pipe as established in the ASTM standard to which the pipe is manufactured. The test shall be performed without mechanical pulling devices.

C) The individual lines to be tested shall be tested for final acceptance no sooner than 30 days after they have been installed.

D) Whenever possible and practical, the testing shall initiate at the downstream lines and proceed towards the upstream lines.

E) No pipe shall exceed a deflection of 5%.

F) In the event that the deflection exceeds the 5% limit in 10% or more of the manhole intervals tested, the total sewer project shall be tested.

h) Joints and Infiltration

1) Joints

The type and method of making joints and the materials used shall be included in the specifications and also shall be shown on the plans. Sewer joints shall be specified to minimize infiltration and to prevent the entrance of roots. Joint material shall conform to ASTM standards. Cement grout joints shall not be used for pipe to pipe joints.

2) Leakage Testing

Leakage tests shall be specified.

A) Test Sections

The design specifications shall provide that the first 1200 feet and at least 10% of the remainder of the sewer project shall be tested for leakage. The entire length of a sewer of less than 1200 feet shall be tested for leakage. In the event that 10% or more of the manhole intervals tested do not pass the leakage test, the entire sewer project shall be tested.

B) Testing Methods

Testing methods may include appropriate water or low pressure air testing. The use of television cameras or other visual methods for inspection prior to placing the sewer in service and prior to acceptance is recommended.

C) Water Testing

i) The leakage outward or inward (exfiltration or infiltration) shall not exceed the following limits in gallons per inch of pipe diameter per mile per day for any section of the system:

Exfiltration: 240

Infiltration: 200

ii) An exfiltration or infiltration test shall be performed with a minimum positive head of 2 feet.

D) Air Testing

If used, the air test shall, as a minimum, conform to the test procedure described in Section 31-1.11B of Standard Specifications for Water and Sewer Main Construction in Illinois, 5th ed. (1996)(no later additions or amendments). The specifications shall require that the time required for a pressure drop from 3.5 to 2.5 PSIG not be less than the time specified in the Air Test Table in Appendix C. The testing methods selected should take into consideration the range in groundwater elevations projected and the situation during the test.

i) Service Connections

Sewer service connections shall meet the same criteria as public sanitary sewers described elsewhere in this Subpart C except as noted in this subsection (i). Roof and foundation drain connections to the sewer service connection are prohibited except as provided for in 35 Ill. Adm. Code 306.302. The service connection tap into the public sewer shall be watertight and shall not protrude into the public sewer. If a saddle type connection is used, it shall be a commercially available device designed to join with the types of pipe that are to be connected. All materials used to make service connections shall be compatible with one another and with the pipe materials to be joined, and shall be corrosion-proof.

1) Size

Service sewers and fittings shall be a minimum of 4 inches in diameter, but shall not be less than the diameter of the plumbing pipe from the building.

2) Slope

Service sewers shall have a minimum slope of 1%.

3) Alignment

When straight line alignment is not maintained on service connections, cleanouts or manholes shall be provided at points of changes in alignment.

(Source: Amended at 21 Ill. Reg. 12444, effective August 28, 1997)