Three-Edge Bearing Strengths
Nonreinforced Concrete Pipe and Clay Pipe

Pipe strength classifications established by manufacturing and material standards for nonreinforced concrete pipe and clay pipe are based on three-edge bearing test strengths expressed in pounds per linear foot. These test strengths are directly related to the load carrying capacity of the buried pipe. Although the methods of presenting the strength classes of these two pipe materials are similar, nonreinforced concrete pipe strength classes provide the designer with additional latitude in selecting pipe strengths to satisfy a broader range of performance requirements.

STRENGTH COMPARISONS

The American Society for Testing and Materials (ASTM) Specification C14, Concrete Sewer Storm Drain and Culvert Pipe, covers the three strength classes of nonreinforced concrete pipe. ASTM Specification C700, Extra Strength and Standard Strength Clay Pipe and Perforated Clay Pipe, covers two strength classifications of clay pipe. Table 1 presents a comparison of the specified minimum three-edge bearing strengths of the three classes of nonreinforced concrete pipe versus the standard strength class and extra strength class of clay pipe through 24 inch diameter. Class 1 minimum three-edge bearing strengths for nonreinforced concrete pipe exceed or meet the minimum three-edge bearing strengths of standard strength clay pipe in each size. Class 2 nonreinforced concrete pipe provided the designer with intermediate strengths and the option to select a strength meeting load requirements more realistically and economically. Figure 1 presents these comparisons in graphic form and enables the designer to readily determine the inherent structural advantages of nonreinforced concrete pipe.

TESTING PROCEDURE

The complete procedure of testing concrete pipe and clay pipe are contained in ASTM Standard C497, Methods of Testing Concrete Pipe and Tile, and ASTM Standard C301, Methods of Testing Clay Pipe. The external load crushing strength test with the load applied by three-edge bearing is the accepted test method for both clay and concrete pipe. The test procedures are similar, except when wooden bearing strips are used for clay pipe plaster of paris must be cast on the contact edges since the barrel of the pipe is often irregular. This same procedure may be employed in the testing of concrete pipe if it is mutually agreed upon by the manufacturer and purchaser prior to testing.

SELECTION OF PIPE STRENGTH

The required three-edge bearing strengths for concrete pipe and clay pipe are computed by the equation:

<table>
<thead>
<tr>
<th>Diameter</th>
<th>Nonreinforced Concrete</th>
<th>Clay</th>
<th>Extra Strength</th>
<th>Diameter</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Class 1</td>
<td>Class 2</td>
<td>Class 3</td>
<td>Standard Strength</td>
</tr>
<tr>
<td>4</td>
<td>1500</td>
<td>2000</td>
<td>2400</td>
<td>1200</td>
</tr>
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<td>2600</td>
<td>3600</td>
<td>4400</td>
<td>2600</td>
</tr>
</tbody>
</table>
T.E.B. = \frac{W_L + W_E}{L_f} \times \text{F.S.} \tag{1}

where:

T.E.B. = \text{three-edge bearing strength, pounds per linear foot}

W_L = \text{live load, pounds per linear foot}

W_E = \text{earth load, pounds per linear foot}

L_f = \text{load factor}

F.S. = \text{factor of safety}

**EXAMPLE 1**

Given: A 24-inch diameter sanitary sewer line is to be installed on a Class B bedding with a load factor (L_f) of 1.9, in a trench 17 feet deep, with a factor of safety of 1.5. Live load is negligible. Earth load is 4372 pounds per linear foot.

Find: The required strength class of nonreinforced concrete pipe and clay pipe to carry the field loads.

Solution: Determine the required three-edge bearing test strength from equation (1).

\[
\text{T.E.B.} = \left( \frac{W_L}{1.5} + \frac{W_E}{L_f} \right) \times \text{F.S.}
\]

\[
= \frac{4372}{1.9} \times 1.5
\]

= 3452 pounds per linear foot

Using Table 1, locate 24-inch diameter in appropriate column. Proceeding to the right determine most economical class of nonreinforced concrete pipe that exceeds the 3452 T.E.B. strength required. Follow same procedure to determine required class of clay pipe.

**Answer:** A Class 2 nonreinforced concrete pipe or an extra strength clay pipe is required. The required strength class could also have been obtained from Figure 1.

**EXAMPLE 2**

Given: A 12-inch sanitary sewer line is to be installed in a 2 1/2-foot wide trench with 13 feet of cover over the top of the pipe. The pipe will be back-filled with ordinary clay weighing 120 pounds per cubic foot. A Class C bedding is specified and a factor of safety of 1.5 will be used. Live load is negligible and earth load is 2137 pounds per linear foot.

Find: The required strength class of nonreinforced concrete pipe and clay pipe to carry the field loads.

Solution: Determine the required three-edge bearing test strength from equation (1).

\[
\text{T.E.B.} = \left( \frac{W_L}{1.5} + \frac{W_E}{L_f} \right) \times \text{F.S.}
\]

\[
= \frac{2137}{1.5} \times 1.5
\]

= 2137 pounds per linear foot

Enter Figure 1 at D=12 inches on the horizontal scale and project a vertical line to the nonreinforced concrete pipe class and clay pipe class which has a three-edge bearing strength greater than 2137 as indicated on the vertical scale.

**Answer:** A Class 2 nonreinforced concrete pipe or an extra strength clay pipe is required. The required strength class could also have been obtained from Table 1.

*maximum live load factor of 1.5 is recommended.*