UNIFORM SOIL GROUPS FOR PIPELINE INSTALLATION

SUMMARY

- In ASTM and AWWA standards, the same soil is referred to differently
- Uniform soil groups can prevent confusion and waste
- The standards need to be changed

INTRODUCTION

Currently, there is little agreement between installation standards as to terminology for soil groups for pipeline construction. Pea gravel is a common material used for pipe installation. Basically, pea gravel is gravel particles about the size of peas, about 3/8-inch inch. If a designer wanted to specify pea gravel for the embedment for a pipeline, the specification would have to resemble the following:

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PVC sewer pipe embedment shall be Class II soil. The embedment for fiberglass pipe for the discharge pipe shall be SC2 soil. The concrete pipe storm drain shall be embedded in Category I soil. Install the ductile iron water pipe in Type 4 laying condition. Steel pipe shall be embedded with coarse-grained soils with little or no fines. The PE storm drain embedment shall be Class II soil. Clay pipe shall be embedded with suitable bedding material. Embedment for CMP shall be structural backfill. The PE pressure pipe embedment shall be clean gravel. The low-head concrete pipe shall use granular soil with less than 5% fines.
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As illustrated, pea gravel is referred to with nine different terms. This complicates the specifications, confuses the contractor, and burdens the inspector with several references to consult.

The author has recommended uniform soil groups for pipeline installation as shown in Table 1 (Howard 2009). The system has been adopted into two ASTM standards (D 2321 and D 2774) and is the foundation of several others, only with different group names (e.g. SC1). Efforts are currently (2012) underway to amend the other standards accordingly.

Using the recommended soil groups, the above specification would say simply:

“The embedment soil shall be Class II material.”
CURRENT TERMINOLOGY

The language in pipe installation standards and specifications should be as clear, concise, and consistent as possible. Accordingly, there should be uniformity in all the soil groupings for buried pipe installation. In the ASTM and AWWA standards for different pipe types, the exact same soil is variously described as “Class II”, “SC2”, “Category I”, “Type 4 laying condition”, “Coarse-grained soils with little or no fines”, and “Suitable bedding material,” etc. Why should a pipe designer wade through all the different soil descriptions to select the best soil type for the different types of pipes that could be included in the specifications? Confusion can lead to either over-designed or under-designed pipe. Uniform soil groups will help contractors better understand the type of soil they have to provide and make more accurate bids (are five different soils needed or does one soil fit all requirements?). Pipeline inspectors should not have to refer to many different installation standards to determine whether or not the right soil is being used.

Unnecessary complexity and confusion leads to poor installation and future pipe failures and leaks.

The specifications and project manuals can be simplified by using consistent language in the installation standards. A uniform soil grouping is proposed that can apply to all types of pipe. These soil groups have already been incorporated into some standards. The committees responsible for the other pipe standards and manuals are encouraged to adopt these soil groups.

For pea gravel, the current standards/manuals use the following terminology:

- Reinforced concrete pipe - Storm Drains/Culverts (RCP) Category I soil
- Profile wall polyethylene - Storm Drains/Culverts (PE) Class II soil
- Corrugated metal pipe - Culverts (CMP) Structural backfill
- Fiberglass pipe - Storm Drains/Culverts (FRP) SC2 soil
- PVC Storm Drains/Culverts and Sanitary Sewers (PVC) Class II soil
- Ductile iron pipe – sanitary sewers/water dist (DIP) Type IV conditions
- Vitrified clay pipe - Sanitary Sewers (VCP) Suitable bedding
- Solid wall polyethylene – water distribution (PE) Class II soil or Clean sand/gravel
- Low-head concrete pipe – water transmission (RCP(LH)) granular soil with <5% fines
- Steel pipe – Water Transmission (steel) coarse-grained soils with little or no fines
- Concrete pressure pipe – Water Transmission (RCPP) fine grained soil with < 25% sand
PROPOSED UNIFORM SOIL GROUPS

The uniform soil groups for pipe installation are shown in Table 1. The groups are based on the soil properties when the soil is compacted. The strength or stiffness of the embedment varies with the grouping, Class I is the stiffest soil when compacted and Class V is the least stiff. Class I provides the best support for pipe and Class V the least. Class V is not recommended as embedment or embedment. Class V should also not be used as compacted backfill under pavements for roads or parking lots.

The percent of fines (silt and clay) increase with Class number. Basically, as the amount of silt and clay in a soil increase, the stiffness decreases. Accordingly, the groups decrease in stiffness/strength as the numbers increase. The groupings approximate ratings of soils for strength/bearing capacity/suitability for structure foundations/highway construction from the Navy Design Manual, Bureau of Reclamation Use Chart, AASHTO soil classification, and various textbooks.

DUMPED SOILS

For soils that are dumped into place, Class I and Class II soils are much stiffer than Class III, IV, and V soils. Dumped clayey and silty soils are usually in clods or lumps. The resulting density, or stiffness, depends on the size of the clods (amount of voids between the clods), the moisture content, and how placed into the trench.

The stiffness of dumped Class I and II soils will vary more than if they were compacted. Any difference in Class I and Class II soils depends on how they are placed, the distance they are dropped, and the particle angularity and gradation.
## PROPOSED SOIL GROUPS FOR PIPE INSTALLATION STANDARDS

<table>
<thead>
<tr>
<th>Class</th>
<th>Description</th>
<th>Symbols</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td><strong>crushed rock</strong></td>
<td>100% passing 1-1/2-in sieve, (\leq 15%) passing #4 sieve, (\leq 25%) passing 3/8-in sieve, (\leq 12%) passing #200 sieve</td>
</tr>
<tr>
<td>II</td>
<td><strong>clean, coarse grained soils</strong></td>
<td>GW, GP, SW, SP</td>
</tr>
<tr>
<td></td>
<td>or any soil beginning with one of these symbols</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(can contain fines up to 12%)</td>
<td></td>
</tr>
<tr>
<td></td>
<td><em>uniform fine sands (SP) with more than 50% passing</em></td>
<td></td>
</tr>
<tr>
<td></td>
<td><em>a #100 sieve should be treated as Class III material</em></td>
<td></td>
</tr>
<tr>
<td>III</td>
<td><strong>coarse grained soils with fines</strong></td>
<td>GM, GC, SM, SC</td>
</tr>
<tr>
<td></td>
<td>or any soil beginning with one of these symbols</td>
<td></td>
</tr>
<tr>
<td></td>
<td><em>sandy or gravelly fine grained soils</em></td>
<td>ML, CL</td>
</tr>
<tr>
<td></td>
<td>or any soil beginning with one of these symbols</td>
<td></td>
</tr>
<tr>
<td></td>
<td>with (\geq 30%) retained on #200 sieve</td>
<td></td>
</tr>
<tr>
<td>IV</td>
<td><strong>fine-grained soils</strong></td>
<td>ML, CL</td>
</tr>
<tr>
<td></td>
<td>or any soil beginning with one of these symbols</td>
<td></td>
</tr>
<tr>
<td></td>
<td>with (\leq 30%) retained on #200 sieve</td>
<td></td>
</tr>
<tr>
<td>V</td>
<td><strong>fine-grained soils, organic soils</strong></td>
<td>MH, CH, OL, OH, Pt</td>
</tr>
<tr>
<td></td>
<td>high compressibility silts and clays, organic soil</td>
<td></td>
</tr>
</tbody>
</table>

### TABLE 1  SOIL GROUPS IN ASTM D2321-08

**Notes:**
1. Soil classification in accordance with ASTM D 2487
2. Class I crushed rock particles should have all fractured faces.
3. Recycled concrete, slag, shells, and coral should be considered Class II
4. Each pipe type will have different allowable maximum particle sizes next to the pipe
REFERENCES


ASTM STANDARDS

AWWA STANDARDS
AWWA C604-06, "Installation of Steel Water Pipe – 4-inch and Larger,” American Water Works Assn.

AWWA MANUALS