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Crush Strength and Flexibility of Thermoplastic Piping

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The use of the term “crush strength” to piping made of thermoplastic materials is often a cause of confusion for users, producers and installers of these thermoplastic pipe products. This creates a need to examine (1) the meaning of the term crush strength, (2) how it is measured, and (3) the fundamental properties of thermoplastics.

For pipes that may fail by brittle failure, “crush strength” is a measure of the force applied by a flattening load that cracks or breaks the pipe test specimen. The term “crush strength” is also often used loosely to mean the crushing stress that will crack or break a standard test piece of brittle pipe.

Crush strength is usually measured by placing a piece of pipe horizontally between two parallel plates or blocks, loading the assembly so that the pipe is compressed radially 180 degrees apart or “flattened”, and measuring the load required to crack or break the pipe. When pipes made of flexible thermoplastic materials are subjected to this test, fracture does not occur and therefore, there is no end point to the test. In other words, this test method and terminology is only applicable to rigid, more brittle materials that have a definite end point crack or break at some load and corresponding deflection, thus giving a limiting load bearing capacity.

Most thermoplastic pipe behaves as a flexible conduit in the crush strength test described above. This means that the pipe can be flattened to a considerable extent without being damaged. This is a measure of flexibility or, in this case, the ability to flex under externally applied radial loads without detracting from the integrity of the pipe. For this reason, the ASTM standards for many thermoplastic pipes such as ASTM D1785 (PVC pressure pipe), D2241 (PVC pressure pipe), D2665 (PVC dwv pipe), D2661 (ABS dwv pipe), D3033 (PVC sewer pipe), D3034 (PVC sewer pipe), and D2751 (ABS sewer pipe) contain a flattening test. The flattening tests provide a measure of the flexibility or “stiffness” of the thermoplastic pipe. This flexibility of the pipe is critical to its ability to transfer soil loads and perform properly when installed underground. This is one of the fundamental aspects of flexible pipe theory used when designing these systems.

In summary, crush strength methods are typically not applicable to thermoplastic pipes because of the high degree of flexibility of this type of material, just as rigid pipe theory is not used when designing underground pipe systems of flexible pipe. Therefore, the normally used term “crushing strength” is not meaningful for flexible thermoplastic pipes. The pertinent test methods for flexible pipes are the flattening method and the pipe stiffness method. Thus, the terminology most applicable to thermoplastic pipe would be flattening, flexibility, or pipe stiffness.

Readers interested in the basic concepts of loads on rigid and flexible pipes can find more detail in chapters 24 and 25 in the book by M.G. Spangler, “Soil Engineering,” 1960, International Textbook Company, Scranton, Pennsylvania.

NOTE: This PPFA User Bulletin is designed to provide guidance in achieving the efficient, effective and proper use of plastic pipe. The suggestions and advice contained in this Bulletin are offered merely to provide plastic pipe users with a general frame of reference. Because specific situations may, and often do require special treatment, the suggestions and advice are obviously not universally applicable. Therefore, the user should carefully assess the requirements of his specific situation before making practical application of anything contained in this publication.
factor of the system.

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