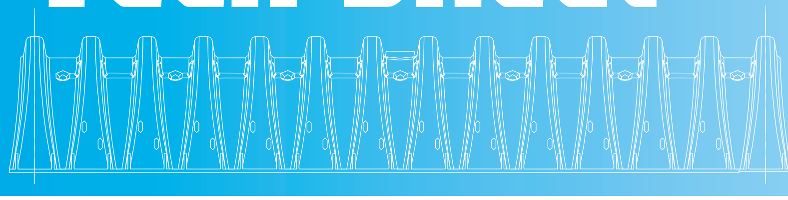
Tech Sheet



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ASTM & AASHTO Standards for Buried Thermoplastic Structures

Tech Sheet # 6
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Design Requirements for Thermoplastic Structures:

1. **The structural design must evaluate short term live loads, intermediate term loads and long term soil loads.**
2. **The materials used in production must provide necessary short, intermediate and long term properties.**
3. **The structural design must be completed by experts in the field of soil-structure interaction.**
4. **The product must be designed and manufactured to meet meaningful standards.**
5. **The structural design of the subsurface stormwater system must be up to the standards that a professional engineer expects.**

General:
This summarizes key components of structural design and national standards for subsurface thermoplastic structures. Although the focus of this guidance is on chamber systems, the principles apply to the wider category of buried products of various structural shapes and material properties.

Structural Design of a Subsurface Thermoplastic System:
The objective of *structural* design is to ensure a proper safety factor over the intended ***service life*** of the buried system. Typically the intended service life of a subsurface storm drainage system ranges from 20 to 100 years. Since the polypropylene and polyethylene, thermoplastic materials now used for subsurface structures are very stable in the stormwater environment; the limiting criterion for service life is generally long-term structural stability.

The primary benefit of subsurface systems is to facilitate additional paved surfaces for the purpose of parking or traffic flow. For such applications, where public safety is of paramount importance, "structural survival", i.e. lack of failure, is not sufficient. For a design to be safe, structural ***safety factors*** must be demonstrated for the entire service life of the project to account for uncertainties in loading, installation, and material performance. AASHTO design procedures mandate load factors of 1.75 for live loads to account for impact effects and the presence of multiple or overweight loads and 1.95 for earth loads on buried culverts.

There are two components to ensuring long term performance of any structural product: 1) the product must be designed, tested and manufactured to meet meaningful ***product standards*** and 2) the system must be designed to meet meaningful ***design standards***. ASTM and AASHTO, the most respected, dependable standards available, have developed standards for buried structures.

Short Term Properties, Intermediate Term Properties, Long Term Properties, Strain and Deflection:
Buried thermoplastic products must be designed for three conditions: 1) short duration live loads under shallow cover, 2) minimum 1-week sustained loads and 3) permanent earth loads. ***Load duration*** is a key criterion for the design of thermoplastic structures since the "apparent strength" and stiffness decrease with increasing load duration. For live load design, the thermoplastic product must be able to withstand the dynamic load from moving vehicles. *Live load design is based on short duration loads and short term material properties.* Intermediate load design requires the thermoplastic product to withstand 1-week sustained loads from parked oversized loads. *Intermediate load design is based on 1-week duration loads and 1-week material properties.*

1 AASHTO is the American Association of State Highway and Transportation Officials
2 ASTM / ASTM International is the American Society of Testing Materials

Earth (dead) loads are permanent in duration and magnitude. For dead load design, the thermoplastic product must be able to withstand the continuous dead load and remain stable after 75 years or more under sustained load. For thermoplastic systems using structural aggregate (stone) support, the performance of the structure is a function of the ability of the thermoplastic structure to a shed significant portion of the load to the surrounding stone (arching). *Earth load design is based on permanent loads and long term material properties.* The material properties that govern long-term design are tensile creep rupture and creep modulus.

Strain limits are the maximum strains that can occur before the structure fails. Long, slender shapes are inherently unstable and fail at lower loads by buckling. Wide, flat shapes may also buckle under continuous load. Design for long-term service life must be based on long duration loads, long term creep modulus and strain limits. ***Without proper soil support, thermoplastic structures may reach a strain limit and fail.***

Deflection is generally not a failure limit or a service limit for soil supported chamber systems. When deflection is not limited by soil support, excessive deflection of thermoplastic structures has been found to cause pavement distress. ***Without proper soil support, deflection is a service limit for thermoplastic structures.***

Specifying industry standards, not just products, establishes objective, meaningful performance criteria and a defensible basis of design.

AASHTO Standards:

The AASHTO LRFD Bridge Design Specification is the primary source of design standards for soil-structure interaction under traffic loads. Section 3 of this specification provides for calculation of loads and Section 12.12 provides for structural design of buried thermoplastic structures.

The AASHTO standard:

- **Assures design safety factors for live loads and long-term loads**
- **Provides the design method for soil-structure interaction**
- **Assures a long-term service life by designing for creep and strain limits**
- **Provides consulting engineers with a defensible basis of design**

ASTM Standards:

ASTM is an internationally recognized source for a variety of standards including; testing methods, standard practices and product specifications. ASTM has developed two product standards for Stormwater chambers, designations ASTM F2418 (polypropylene chambers) and ASTM F2922 (polyethylene chambers).

The ASTM F 2418 and F2922 Standards:

- **Assure consistent product quality in a non-proprietary specification**
- **Establish physical and mechanical requirements for the finished product**
- **Establish long and short-term material properties for design**
- **Require AASHTO safety factors and full scale validation testing**

ASTM has developed a design standard for Stormwater chambers, designation: ASTM F 2787, entitled “Standard Practice for Structural Design of Thermoplastic Corrugated Wall Stormwater Collection Chambers”.

The ASTM F 2787 Standard:

- **Applies the AASHTO Section 12.12 thermoplastic pipe design criteria and applies it directly to chambers**
- **Includes an additional design load for a minimum 1-week sustained vehicle load to account for parked vehicles**
- **Provides design criteria that can be applied to different thermoplastic resins.**

Product Design:

Stone support is a key component of the soil-structure interaction system. Stone columns between thermoplastic components provide the load paths from the load above to the foundation below. For stone-structure designs, the stone reduces the load that the thermoplastic components must carry and limits the deflection and strain of the thermoplastic components. Designs of subsurface thermoplastic structures that purport to require no structural stone or are not designed in accordance with AASHTO requirements may result in excessive deflections or complete failure.

StormTech chambers are designed and rigorously tested in accordance with national standards to provide the most reliable subsurface system available.

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